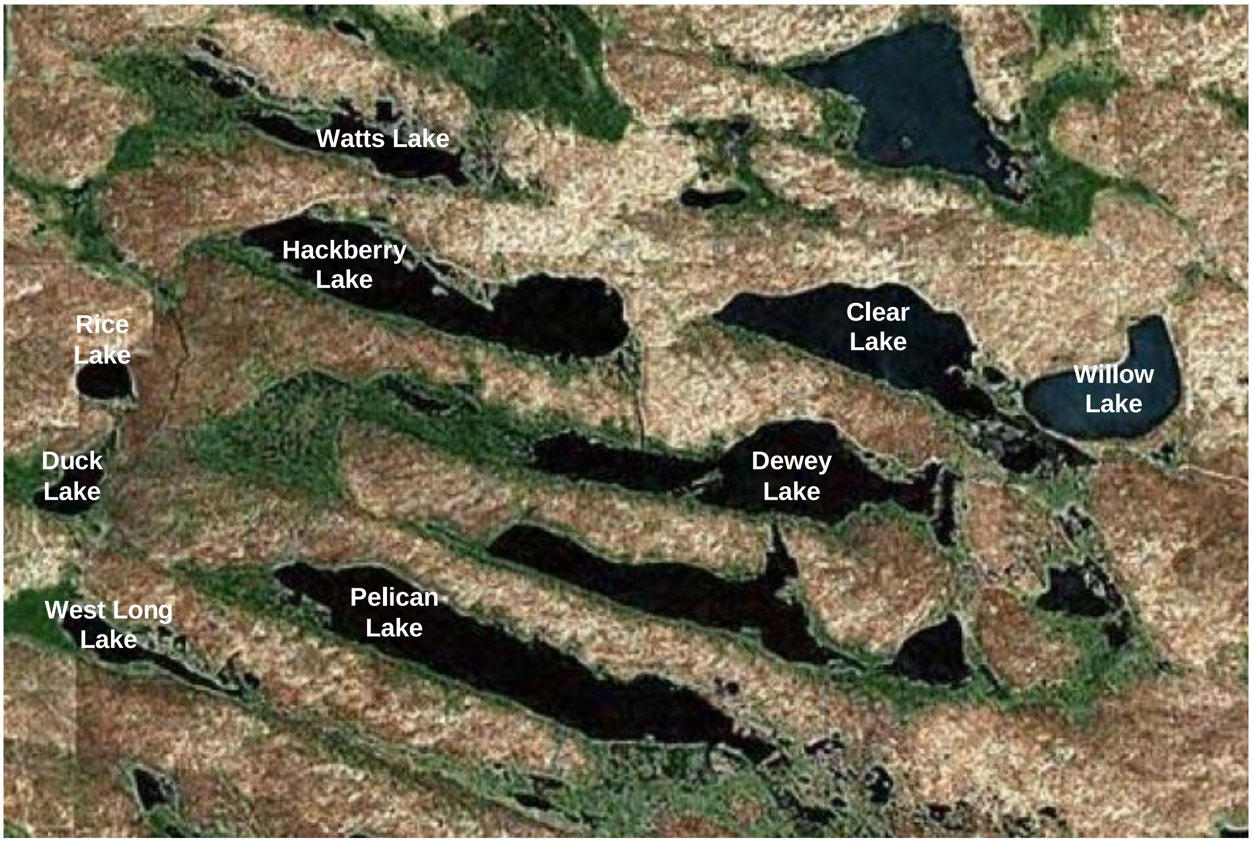
# 2011 FISHERIES SURVEYS
# VALENTINE NATIONAL WILDLIFE REFUGE, NEBRASKA

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# TABLE OF CONTENTS

# INTRODUCTION

The Valentine National Wildlife Refuge (NWR) was established in 1935 to provide feeding and resting areas for migrating waterfowl. Public recreation that is compatible with the purposes of the refuge, including hunting and fishing, is promoted. Management of the fisheries is defined in a 1978 Cooperative Agreement between the U. S. Fish and Wildlife Service (USFWS) and Nebraska Game and Parks Commission (NGPC).

The Valentine NWR contains 39 lakes. The majority of the lakes are small, shallow, potholes that are subject to frequent winter-kills. Nine Lakes are open to fishing: Clear, Dewey, Duck, Hackberry, Pelican, Rice, Watts, West Long, and Willow lakes (Figure A-1). These lakes have varying degrees of potential for fisheries management. All of the designated fishing lakes, except Rice Lake, are accessible by vehicles.

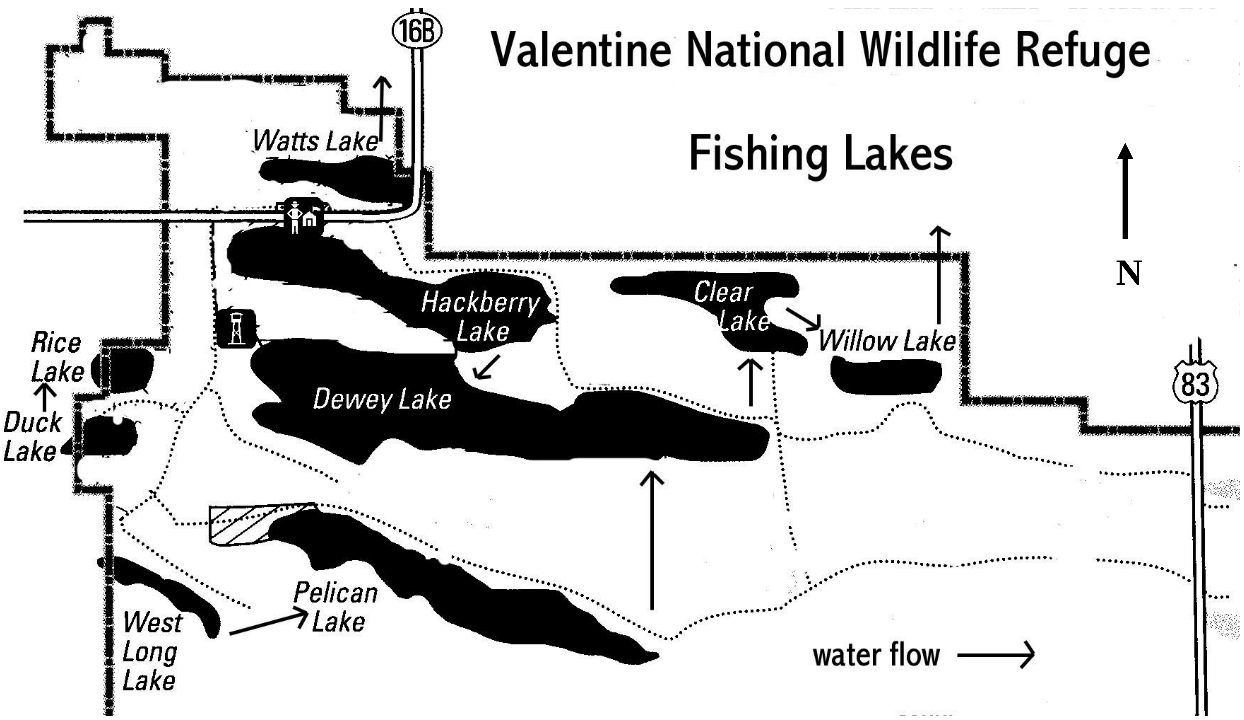


Figure A-1. Map of nine lakes open to fishing on the Valentine NWR. Direction of water flow is depicted by arrows and refuge trails are depicted by dotted lines.

Common carp (*Cyprinus carpio*) gained access to the Valentine NWR lake system through Gordon Ditch, which was dug during the 1930's. Common carp reproduce well in the shallow, highly-vegetated refuge lakes and generally dominate the fishery within 10 years after introduction. Degradation of aquatic habitats by carp is well documented especially for waterfowl (Chamberlain 1948; Robel 1961) and game fish habitat (Cahn 1929). These refuge lakes have a long history of chemical renovation to remove carp. Historically, for about five years after a renovation and re-stocking of game fish (Appendix A), angling is excellent, waterfowl use is high, and then both decline due to carp-induced habitat degradation. Fisheries biologists from the USFWS and NGPC have experimented with the use of northern pike (*Esox lucius*) as a biological carp-control. Early attempts were unsuccessful because northern pike were introduced after carp were well established and subsequently too large to be controlled by predation.

In 1988, northern pike and largemouth bass (*Micropterus salmoides*) length limits were changed for Valentine NWR lakes in an attempt to increase abundance and size structure of predators (Appendix B). The size restrictions appeared to be successful as common carp numbers stabilized in lakes where the restrictions were enacted. However, strong year classes of carp during years where northern pike populations were low have led to recruitment and increased abundance of carp populations in some lakes. Success has not been without perceived drawbacks. Predation by northern pike have reduced the abundance and altered the size structure of largemouth bass, yellow perch (*Perca flavescens)*, and bluegills (*Lepomis macrochirus*) (Paukert and Willis 2003; Paukert et al. 2003; Jolley et al. 2008). Environmental conditions have significant affects on recreational fisheries in these shallow lakes such as a 1987 – 88 winter-kill, low reproduction and recruitment due to drought conditions during the summers of 1989 – 1990 and 2002 – 2007, generally wet and cool springs and summers (< 21$^{o}$C) during 1992, 1993, 2008, 2009, and 2010. The springs of 1994 – 1997 were exceptionally wet, and these conditions provided good habitat and conditions for strong year classes for most fish species. However, high water levels also connected lakes that are usually isolated, which allowed fish movement.

Northern pike have been identified as a possible tool for controlling common carp, and evaluating their potential is a high priority for the Refuge's fisheries. Many of the results from fishery assessments identified in this report are directed at: 1) evaluating northern pike as a biological control agent for carp, 2) evaluating northern pike recruitment and condition in response to the special regulation allowing harvest of northern pike less than 28 in. (710 mm) total length (TL), and 3) evaluating the impacts of the special northern pike regulations on other game fish populations.

A glossary of fishery terms is summarized in Appendix C and data collation and analysis techniques are summarized in Appendix D. Mean lake levels are presented in Appendix E. Due to the abundance of turtles collected in trap nets, monitoring of the painted (*Chrysemys picta*), snapping (*Chelydra serpentina*), and blanding's (*Emydoidea blandingii*) turtles captured during fisheries sampling began in 2008. Turtle data is presented in Appendix F.

# METHODS

Standardized fisheries surveys on Valentine NWR began in 1992 using gill nets, trap nets, and night-time electrofishing. Gill nets have been deployed during the fall, generally in the last week of August to the second week of September each year since 1992. Electrofishing was also conducted in the larger lakes (Clear, Dewey, Hackberry, and Pelican lakes) during the fall from 1992 to 2004. Electrofishing has occurred in the spring during late May to early June since 2005. Trap netting was conducted during the fall from 1992 to 2005 and has been conducted during the spring since 2006. Electrofishing and trap nets were conducted during the spring since 2001 in the smaller lakes (Duck and Watts).

In 2011, electrofishing and trap net surveys were conducted 14 – 16 June and gill net surveys were conducted 29 – 30 August in Clear, Dewey, Hackberry, Pelican, and Watts lakes (Table A-1). Night-time electrofishing was conducted with a Smith and Root model 5.0 GPP electrofishing system rated at 5,000 watts of output power, using pulsed DC at 4 – 6 amps and 60 pulses per second. Electrofishing was conducted in 10 or 15 minute transects along the shoreline. Trap nets consisted of a lead anchored at the shoreline that is 15.2 m (50 ft) in length by 1 m (3 ft) in height, two, 1.2 m (4 ft) wide and 1 m (3 ft) high rectangular steel frames, and two, 1 m (3 ft) diameter circular hoops with 13 mm (0.5 in) nylon mesh. A green protective coat was applied to the nylon mesh. Trap nets were set overnight for a maximum of 24 h with leads set perpendicular to the shore. Gill nets were experimental monofilament nets that were 38.1 m (125 ft) in length, 1.8 m (6 ft) in depth, with five 8-m (25 ft) long panels with bar mesh sizes, in order, of 19 mm (0.75 in), 25 mm (1 in), 38 mm (1.5 in), 51 mm (2.0 in), and 76 mm (3 in). Float lines were 1.3 cm poly-foamcore and lead lines were 22.7 kg leadcore. Gill nets were always set with the small mesh closest to the shore.

Table A-1. Effort for each gear in each lake sampled on the Valentine NWR during 2011.

| Lake | Electrofishing (min) | Spring trap net nights (N) | Fall gill net nights (N) |
|---|---|---|---|
| Clear | 120 | 10 | 5 |
| Dewey | 75 | 10 | 5 |
| Hackberry | 90 | 12 | 7 |
| Pelican | 105 | 12 | 7 |
| Watts | 60 | 7 | 3 |

# CLEAR LAKE

## Lake Description

Clear Lake is accessed by gravel roads from County Highway 16B or U.S. Highway 83. Ice fishing is popular during winters with good ice conditions. During the spring and again during fall, northern pike fishing is popular.

Clear Lake is in the middle of a series of four lakes on the refuge connected by natural drainage and man-made ditches. A ditch dug from Dewey Lake (upstream from Clear Lake) feeds into Clear Lake. The interconnection of these lakes has created problems with controlling inter-lake fish movement in past years. The spring of 1995 and 1997 were years of high run-off resulting in extremely high lake levels. Water flowed from Clear Lake downstream to Willow Lake for much of the spring and summer and inter-lake fish movement was observed.

Clear Lake is 172 surface ha (424 acres) with a maximum depth of 3.5 m (10.2 ft.) and mean depth of 1.7 m (6 ft.) during full pool. A dike on the east end can hold the lake about 1.2 m higher than the natural pool level. The added area is primarily flooded sand dunes and provides little fisheries habitat. The bottom is relatively flat with few drop-offs or depressions. Most of the bottom is sandy, but a small bay on the east end of the lake contains an expanse of highly organic benthos. The surrounding shoreline is predominately grass with a few willow (*Salix spp.*) and cottonwood (*Populus deltoids*) trees. High water levels are required to flood shoreline vegetation for spring spawning sites. The limited littoral area reduces spawning and subsequent survival for most of the lake's game fish species. Aquatic vegetation is sparse around the edges. Less than 2% of the lake contains emergent vegetation (primarily cattails [*Typha spp.*]), and submergent vegetation is nearly absent. The lack of vegetation is related to an infertile sandy bottom and high turbidity. Surface water quality parameters measured in Clear Lake during each survey (Table B-1) are conductivity, dissolved oxygen, total alkalinity, phenolphthalein alkalinity, pH, and Secchi disk depth. The lake is too shallow to develop a thermocline. Additionally, water chemistry analysis was performed to determine nitrite, nitrate, total nitrogen, ammonia, ortho-phosphorous, and total phosphorous levels for Clear Lake (Appendix I).

The last renovation with rotenone occurred in 1983; Clear Lake was restocked with game fish such as northern pike, largemouth bass, yellow perch, bluegill, and black crappie (*Pomoxis nigromaculatus*; Appendix A). During the 1986 survey, sub-adult carp were collected for the first time since that renovation. Northern pike greater than 28 in (710 mm) have been protected since 1993. Since enactment of these regulations, fall surveys generally indicated improved size structure and condition of northern pike. Mean $W_r$ of northern pike has been stable across the years. Since the size limit was enacted in 1993, the most notable difference has been the increase of memorable to trophy length northern pike. Fish in this length category have been collected every year since 1996 with incremental RSD-M values ranging from 5 to 27.

Primary fish species in Clear Lake include northern pike, common carp, largemouth bass, bluegill, yellow perch, black bullhead (*Ameiurus melas*), and black crappie. The lake has been described as having a boom or bust fishery.

Table B-1. Clear Lake surface water quality parameters from 1999 to 2011.

| Date | Time | Water temp. (°C) | D.O. (mg/L) | Secchi depth (cm) | pH | Salinity (ppt) | Phenolphthalein alkalinity (mg/L) | Total alkalinity (mg/L) | Conductivity (µS/cm) |
|---|---|---|---|---|---|---|---|---|---|
| 08/2011 | | 25 | 8.7 | 61 | 9.2 | | 0 | 291 | 486 |
| 08/2011 | | 25 | 9.0 | 78 | 9.1 | | | | 499 |
| 06/2011 | | 20 | 7.9 | | 8.8 | | 17 | 171 | 471 |
| 08/2010 | 1835 | 24 | 10.8 | | 9.3 | | 0 | 188 | 509 |
| 05/2010 | | 12 | 9.7 | | 8.5 | | 0 | 257 | 429 |
| 08/2009 | 1230 | 23 | 8.4 | | 8.9 | | 0 | 239 | 558 |
| 06/2009 | 2100 | 17 | 8.9 | 57 | 8.4 | | 34 | 202 | 522 |
| 05/2009 | 1745 | 20 | 7.7 | 180 | 9.0 | | 17 | 238 | 548 |
| 09/2008 | | 19 | 9.7 | | 8.9 | 0.34 | 0 | 308 | 615 |
| 05/2008 | | | 11.3 | | | 0.30 | 17 | 222 | 466 |
| 05/2007 | | 19 | 8.7 | 91 | 7.0 | 0.30 | 17 | 308 | 666 |
| 08/2006 | | 21 | 8.1 | | 7.1 | 0.30 | 0 | 257 | 649 |
| 08/2005 | | 22 | | | 7.2 | | 0 | 290 | |
| 09/2003 | | | 9.2 | | | | | | |
| 09/2002 | | 21 | 6.0 | | 8.1 | | 0 | 513 | 500 |
| 09/2001 | | 18 | | 60 | 7.2 | | 0 | 205 | 486 |
| 07/2001 | 1800 | 26 | 13.0 | | 7.7 | | 60 | 196 | |
| 07/2001 | 0700 | 23 | 7.4 | | 9.5 | | 0 | 196 | |
| 09/2000 | | 17 | | 30 | 8.4 | | 0 | 308 | 590 |
| 09/1999 | | 16 | | | 8.2 | | | | |

# Results and Discussion

## <u>Common carp</u>

During 2011, gill net relative abundance for common carp in Clear Lake was at an all time high since the 28 inch length limit was enacted in 1993 (Figure B-1). Successful spawning of common carp occurred in Clear Lake during 2009 and that cohort recruited to the population as relative abundance of stock length (≥ 280 mm) fish substantially increased from 2008 to 2011. Spawning success was likely low in 2011, as most common carp collected by gill nets were stock length (Figure B-2) and no common carp < stock length were captured. Trap net data also suggested limited spawning success because 71% of the common carp captured in trap nets were stock length while no fish < stock length were captured.

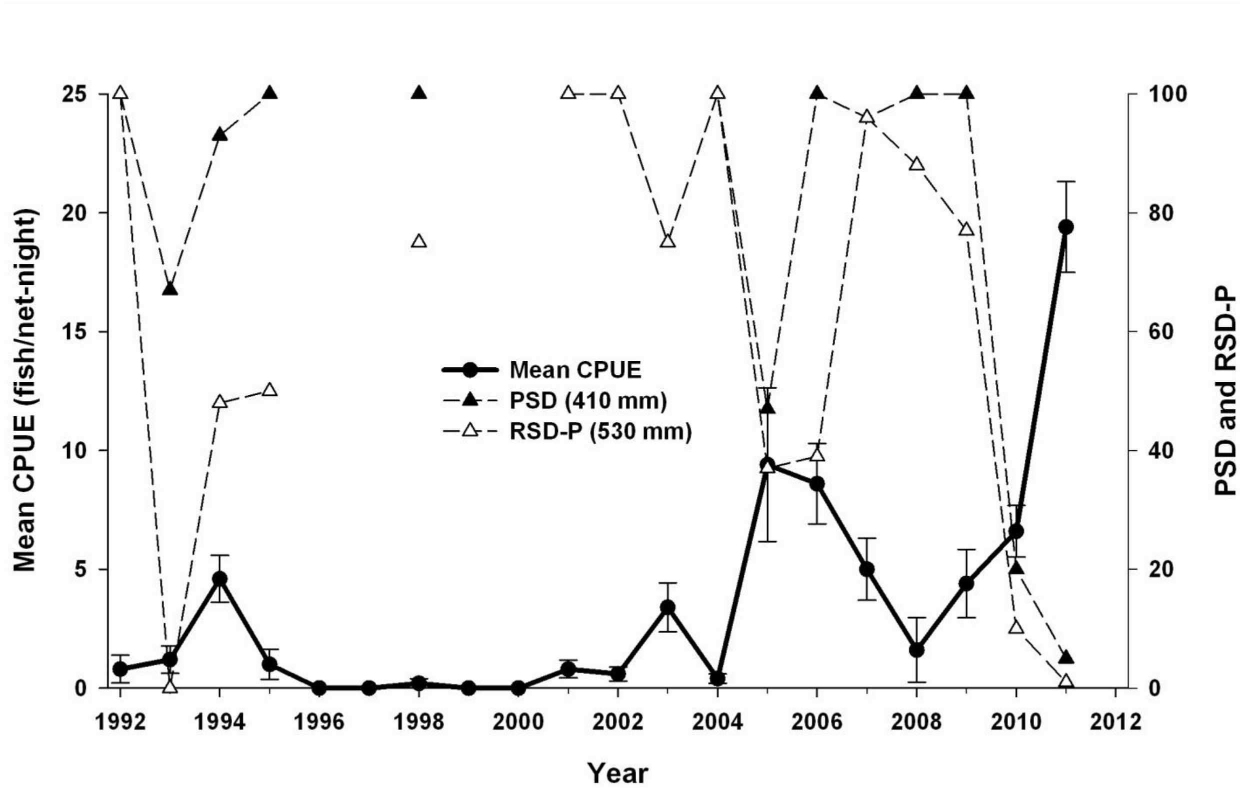


Figure B-1. Annual relative abundance (fish/net-night with SE bars), proportional size distribution (PSD), and relative size distribution (RSD-P) of common carp captured by gill nets in Clear Lake from 1992 to 2011. Mean catch per unit effort (CPUE) calculated for carp ≥ stock length (280 mm) only.

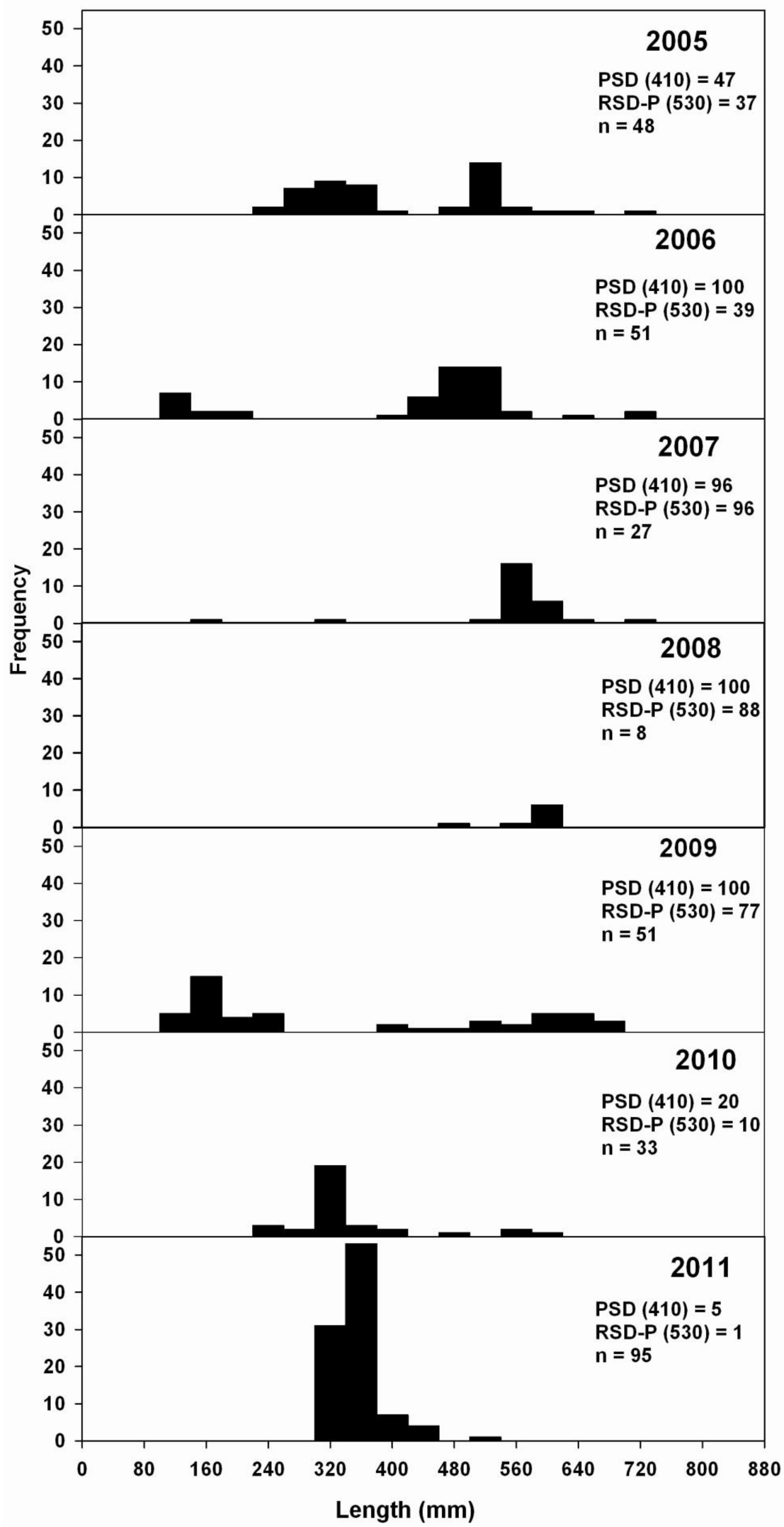


Figure B-2. Length frequency distribution (40-mm length groups) of common carp captured in gill nets in Clear Lake, Valentine NWR, from 2005 to 2011.

## Northern Pike

The size structure of northern pike in Clear Lake has not substantially changed over the past eight years (Figure B-3) as PSD ranged from 96 to 100 (Table B-2). Gill net relative abundance was not significantly different in 2011 ($P > 0.20$) than all other years (1992 – 2010) since standardized gill net surveys have taken place (Figure B-4). The northern pike population was dominated by quality to preferred (530 – 709 mm) and preferred to memorable (710 – 860 mm) length fish (Figure B-5). Clear Lake continues to have the highest relative abundance of preferred length fish compared to Pelican and Dewey Lakes. Mean $W_r$ continued to decline to 87 in 2011, from 93 in 2010 and 99 in both 2008 and 2009 (Table B-2). Northern pike $W_r$ remained similar to other Sandhill lakes (Paukert and Willis 2003), which indicated an abundance of prey available in Clear Lake. Since the 28 in maximum size limit in 1993, the most notable differences in RSD values have occurred for memorable to trophy length fish. Fish in this length category have been collected every year since 1996 with incremental RSD-M values ranging from 5 to 27 (Table B-2).

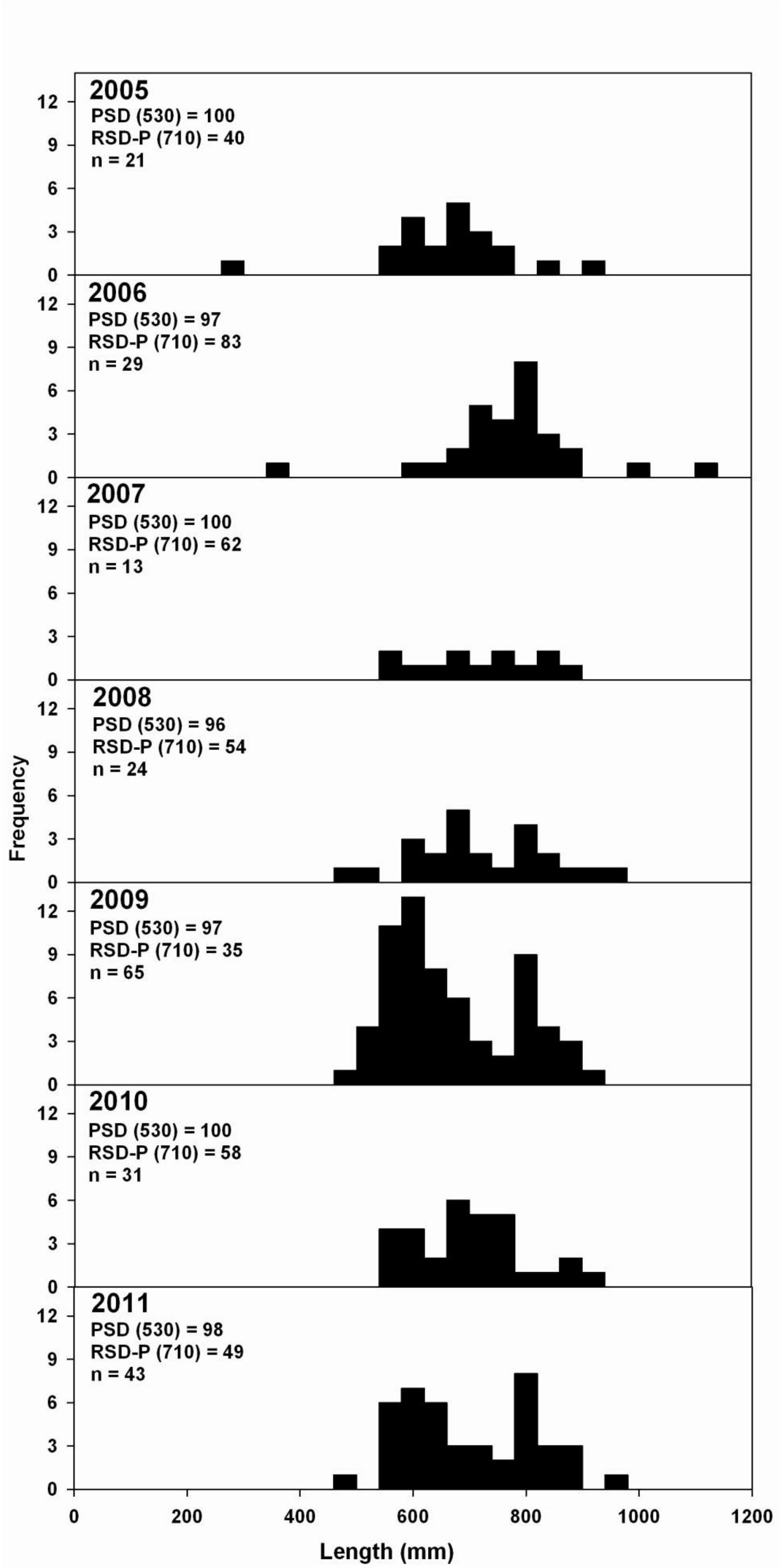


Figure B-3. Length frequency distribution (40-mm length groups) of northern pike captured by gill nets during the fall in Clear Lake from 2005 to 2011.

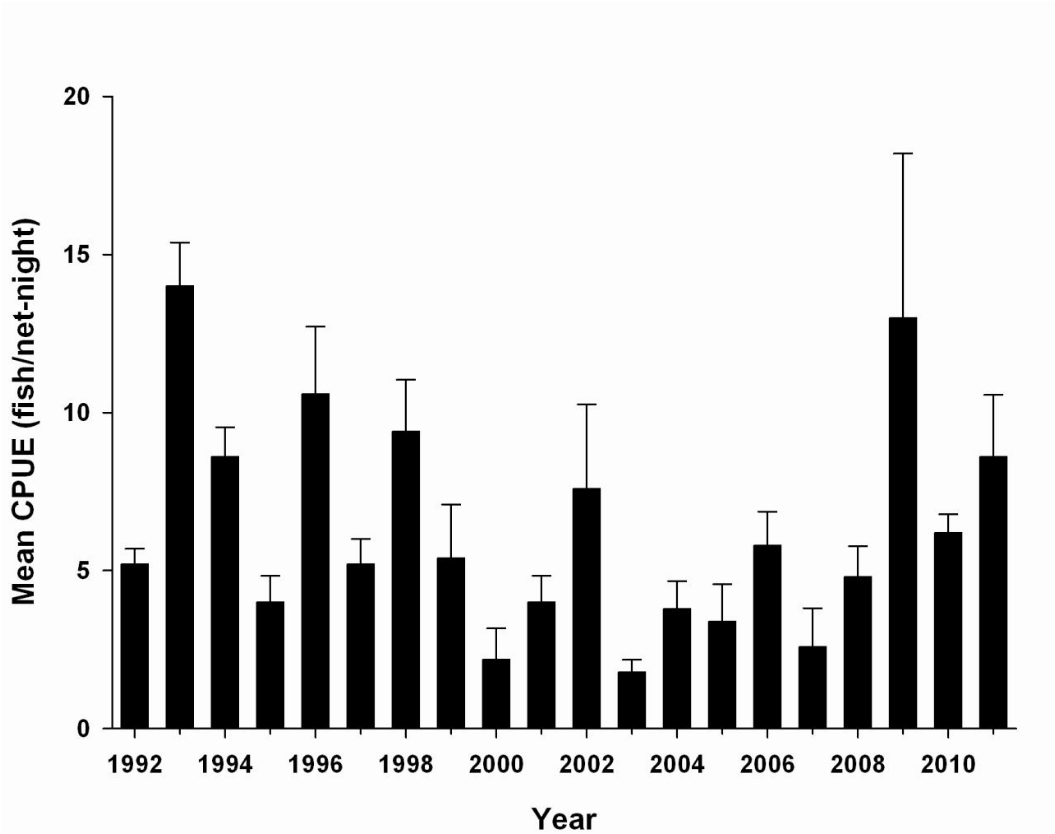


Figure B-4. Northern pike gill net mean catch per unit effort (CPUE) in Clear Lake from 1992 to 2011. Relative abundance during 2011 was not significantly different (P > 0.20) from the previous years using an ANOVA.

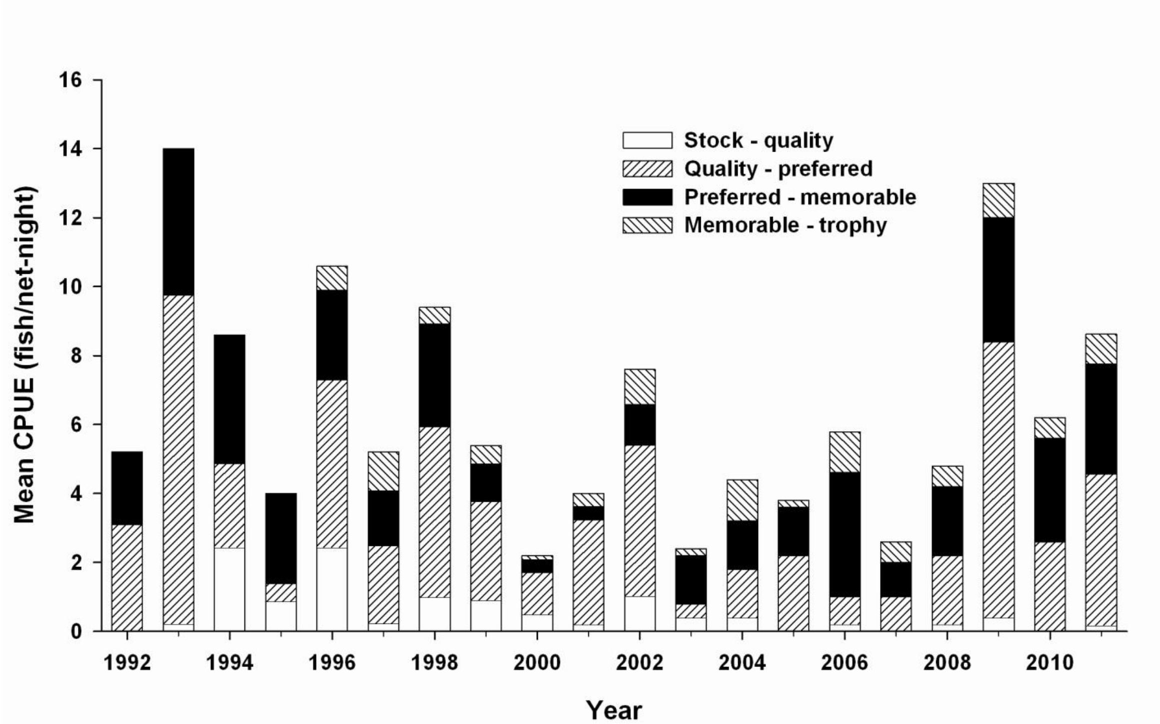


Figure B-5. Gill-net mean catch per unit effort (CPUE) for northern pike by length category in Clear Lake from 1992 to 2011.

Table B-2. Population size structure, traditional proportional size distribution (PSD) and incremental relative size distribution (RSD) with relative weights ($W_r$) of northern pike in Clear Lake during the fall. 2006 – 2010 data for gill netting only. Data are pooled for fall trap nets and gill nets from 1988 to 2005. Data are summarized by length categories with 80% confidence intervals (+/-; Gustafson 1988).

| Year | % ≥ Quality | | Stock - Quality (350-530mm) (14-21 in) | | | Quality to Preferred (530-710mm) (21-28 in) | | | Preferred to memorable (710-860mm) (28-34 in) | | | Memorable to trophy (860-1120mm) (34-44 in) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PSD | $W_r$ | RSD | +/- | $W_r$ | RSD | +/- | $W_r$ | RSD | +/- | $W_r$ | RSD | +/- | $W_r$ |
| 2011 | 98 | 87 | 2 | a | 93 | 51 | 12 | 84 | 37 | 12 | 92 | 10 | a | 80 |
| 2010 | 100 | 93 | 0 | | | 42 | 14 | 93 | 48 | 16 | 91 | 10 | a | 102 |
| 2009 | 97 | 99 | 3 | a | 93 | 62 | 9 | 101 | 28 | 8 | 97 | 8 | 6 | 94 |
| 2008 | 96 | 99 | 4 | a | 114 | 42 | 18 | 106 | 42 | 18 | 93 | 13 | a | 89 |
| 2007 | 100 | 96 | 0 | a | | 38 | a | 98 | 38 | a | 97 | 23 | a | 87 |
| 2006 | 97 | 93 | 3 | a | 123 | 14 | a | 98 | 62 | 22 | 94 | 17 | a | 83 |
| 2005 | 100 | 93 | 0 | a | | 60 | a | 92 | 35 | a | 95 | 5 | a | 86 |
| 2004 | 91 | 106 | 9 | a | 102 | 32 | a | 113 | 32 | a | 104 | 27 | a | 101 |
| 2003 | 83 | 89 | 17 | a | 89 | 17 | a | 100 | 58 | a | 88 | 8 | a | 79 |
| 2002 | 87 | 86 | 13 | a | 86 | 58 | 16 | 88 | 16 | a | 85 | 13 | a | 83 |
| 2001 | 95 | 87 | 5 | a | 100 | 76 | 16 | 87 | 10 | a | 74 | 10 | a | 98 |
| 2000 | 77 | 79 | 23 | a | 87 | 59 | 5 | 76 | 18 | a | 74 | 6 | a | 76 |
| 1999 | 80 | 84 | 20 | a | 83 | 53 | 14 | 82 | 20 | 12 | 87 | 10 | a | 94 |
| 1998 | 89 | 90 | 10 | 6 | 95 | 53 | 10 | 91 | 32 | 9 | 89 | 5 | a | 82 |
| 1997 | 96 | 94 | 4 | a | 100 | 46 | 7 | 105 | 29 | 6 | 93.0 | 21 | 6 | 97 |
| 1996 | 76 | 101 | 24 | 14 | 101 | 48 | 13 | 102 | 25 | 14 | 101 | 6 | a | 88 |
| 1995 | 78 | 95 | 22 | 14 | 99 | 13 | 13 | 98 | 63 | 15 | 92 | 0 | a | |
| 1994 | 71 | 105 | 28 | 9 | 115 | 28 | 9 | 98 | 43 | 11 | 95 | 0 | a | |
| 1993 | 98 | 97 | 1 | a | 97 | 68 | 11 | 101 | 30 | 9 | 98 | 0 | a | |
| 1992 | 100 | 96 | 0 | a | | 60 | 9 | 96 | 40 | 9 | 97 | 0 | a | |
| 1991 | 100 | 92 | 0 | a | | 87 | a | 94 | 13 | a | 90 | 0 | a | |
| 1990 | | | | | | | | | | | | | | |
| 1989 | 93 | 90 | 7 | a | 95 | 68 | a | 90 | 23 | a | 80 | 2 | a | 87 |
| 1988 | 55 | 110 | 45 | a | 115 | 30 | a | 110 | 15 | a | 95 | 0 | a | |

a = Confidence intervals could not be calculated due to small sample size.

## Black crappie

Over 365,000 black crappie (fry, fingerlings, and adults, combined) were stocked in Clear Lake from 2004 to 2006. This stocking program was initially perceived as having limited success. No stock length (≥ 130 mm) black crappie were collected until fall 2009 in gill nets. This evidence suggested that there was successful spawning, but recruitment to larger sizes had been limited. Relative abundance of black crappie increased in 2011 to 11.3 fish/trap-net night (SE = 4.4) from 3.7 fish/trap–net night (SE = 1.3) in 2010 (Figure B-6). Sub-stock, stock, and quality length black crappie were collected in both trap nets and electrofishing gear in 2011 (Figure B-7). During 2009 – 2011, black crappie successfully spawned in Clear Lake, and recruitment of these cohorts to larger length classes is apparent. Mean $W_r$ declined from 2010, potentially indicating that as the population increases prey resources may become limited (Table B-3).

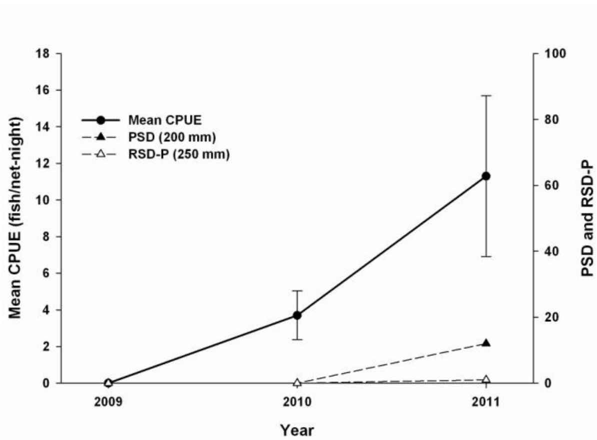


Figure B-6. Annual relative abundance (fish/hr), proportional size distribution (PSD), and relative size distribution (RSD-P) of black crappie captured by trap nets during the spring in Clear Lake during 2009 - 2011. Mean catch per unit effort (CPUE) calculated for black crappies ≥ stock length (130 mm) only.

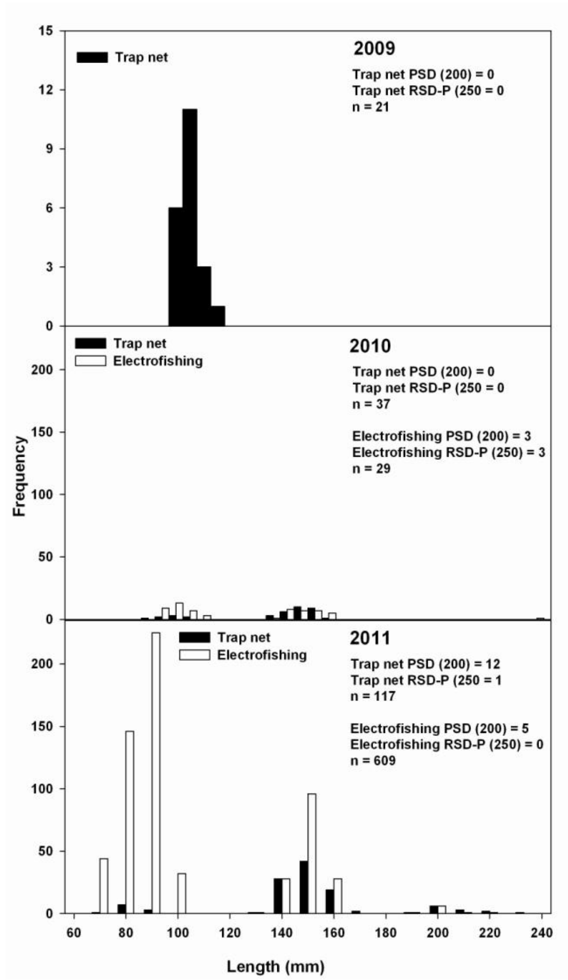


Figure B-7. Length frequency distribution (10-mm length groups) of black crappie collected by trap nets and electrofishing in Clear Lake during 2009 and 2011.

Table B-3. Black crappie mean relative weight ($W_r$) with standard error (SE) in parenthesis by length category captured by electrofishing and trap nets during the spring in Clear Lake from 2009 to 2011.

| Year | ≥ Stock<br>Overall $W_r$ | Stock - Quality<br>(130-200 mm)<br>(5-8 in) | Quality - Preferred<br>(200-250 mm)<br>(8-10 in) | Preferred - Memorable<br>(250-300 mm)<br>(10-12 in) | Memorable - Trophy<br>(300-380 mm)<br>(12-15 in) |
|---|---|---|---|---|---|
| 2011 | 96 (1.3) | 96 (1.7) | 96 (1.8) | b | b |
| 2010 | 104 (1.7) | 104 (1.7) | b | b | b |
| 2009 | a | a | a | a | a |

a = Sampling did not occur or weights were not recorded during that year.
b = Category had less than two samples for mean and SE calculations, but may have been calculated in overall $W_r$.

## **Bluegill**

Relative abundance of bluegills in Clear Lake during 2011 increased 2,550% from 2010 and is at the highest point since 2006 (Figure B-8). The bluegill population was dominated by stock to quality length fish (Figure B-9), which has been the history for bluegills in Clear Lake. Bluegill CPUE (fish ≥ stock length) data from electrofishing surveys was the lowest among refuge lakes sampled in 2011. Overall mean $W_r$ for fish ≥ stock length increased from its all time low in 2010 ($W_r$ = 93; Table B-4) but remained the lowest among the five Refuge lakes surveyed in 2011.

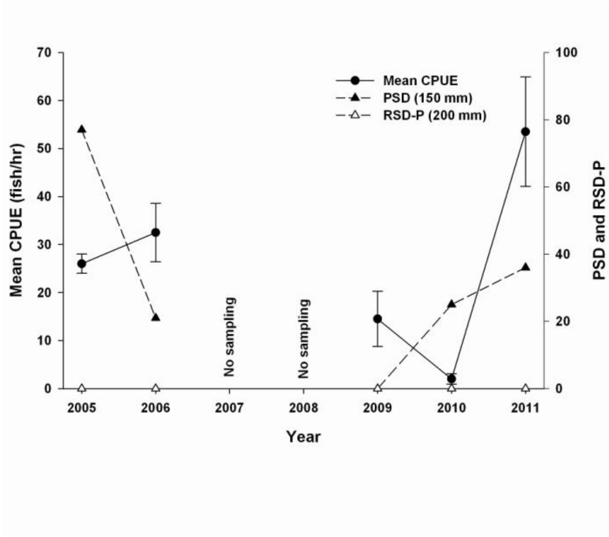


Figure B-8. Annual relative abundance (fish/hr), proportional size distribution (PSD), and relative size distribution (RSD-P) of bluegills captured by electrofishing during the spring in Clear Lake during 2005 - 2006 and 2009 - 2011. Water levels were too low to effectively sample with electrofishing gear from 2007 to 2008. Mean catch per unit effort (CPUE) calculated for bluegill ≥ stock length (80 mm) only.

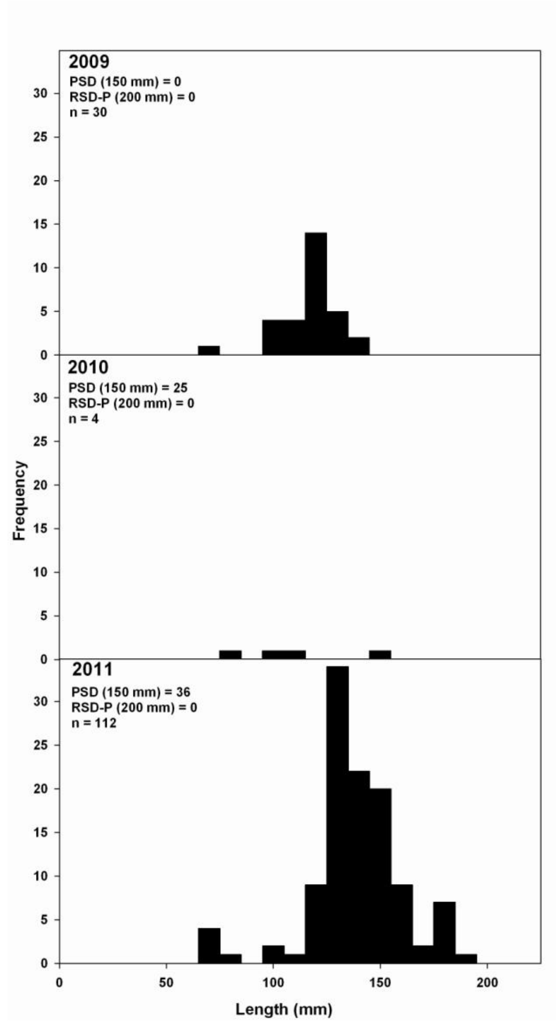


Figure B-9. Length frequency distribution (10-mm length groups) of bluegill collected by electrofishing in Clear Lake during 2009 – 2011.

Table B-4. Bluegill mean relative weight ($W_r$) with standard error (SE) in parenthesis by length category captured by electrofishing and trap nets in Clear Lake from 1992 to 2011. Sampling occurred during fall from 1992 to 2004 and during the spring from 2005 to 2011.

| Year | ≥ Stock Overall $W_r$ | Stock - Quality (80-150 mm) (3-6 in) | Quality - Preferred (150-200 mm) (6-8 in) | Preferred - Memorable (200-250 mm) (8-10 in) | Memorable - Trophy (250-300 mm) (10-12 in) |
|---|---|---|---|---|---|
| 2011 | 106 (3.00) | 106 (3.2) | 105 (5.1) | b | b |
| 2010 | 93 (7.6) | 83 (5.8) | 114 (4.9) | b | b |
| 2009 | a | a | a | a | a |
| 2008 | a | a | a | a | a |
| 2007 | a | a | a | a | a |
| 2006 | 115 (2.0) | 116 (2.4) | 114 (4.0) | b | b |
| 2005 | 121 (3.2) | 124 (5.4) | 118 (2.8) | b | b |
| 2004 | a | a | a | a | a |
| 2003 | 113 (22.9) | 113 (22.9) | b | b | b |
| 2002 | 99 (2.3) | 100 (2.4) | 86 (1.4) | b | b |
| 2001 | 110 (2.1) | 108 (2.0) | 113 (6.5) | 120 (9.7) | b |
| 2000 | 113 (2.0) | 112 (2.4) | 113 (3.9) | 124 (2.4) | b |
| 1999 | 116 (1.5) | 117 (2.2) | 118 (1.9) | 113 (3.9) | b |
| 1998 | 107 (3.0) | 99 (3.7) | 120 (4.0) | 115 (5.2) | b |
| 1997 | 110 (4.2) | 108 (2.6) | 122 (15.9) | b | b |
| 1996 | 117 (2.7) | 113 (4.1) | 112 (3.1) | 123 (2.6) | b |
| 1995 | 111 (1.8) | 110 (2.1) | 115 (3.3) | 123 (2.5) | b |
| 1994 | 133 (4.6) | 115 (4.2) | 142 (5.2) | 153 (4.9) | b |
| 1993 | 107 (6.7) | 107 (6.7) | b | b | b |
| 1992 | b | b | b | b | b |

a = Sampling did not occur or weights were not recorded during that year.
b = Category had less than two samples for mean and SE calculations, but may have been calculated in overall $W_r$.

## **Largemouth bass**

Relative abundance of stock length largemouth bass (≥ 200 mm) increased ≥ 240% in Clear Lake during 2011 (mean CPUE = 51 fish/hr; SE = 2.0) compared to 2009 and 2010 (mean CPUE ≤ 15.0 fish/hr; SE ≥ 3.0). Relative abundance of largemouth bass in 2011 was the highest observed since 2006 (Figure B-10). Size structure continued to improve in 2011 (PSD = 42) compared to 2010 (PSD = 30) and 2009 (PSD = 4) as fish transitioned to quality and preferred lengths (Figures B-10 and B11). Since 2009, largemouth bass appear to be successfully spawning and recruiting into the population. Overall mean $W_r$ continued to decline since 2009; however, it was still high for quality and greater length (≥ 300 mm) fish (Table B-5).

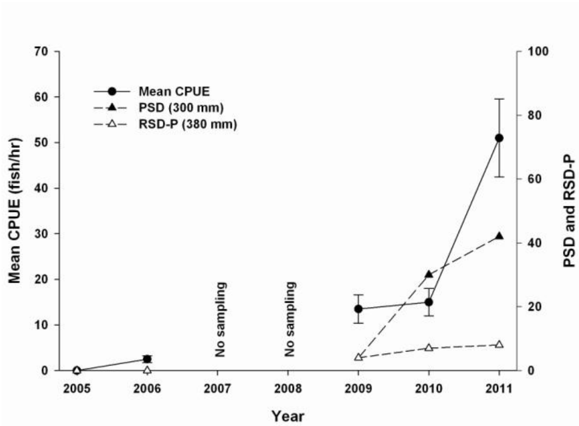


Figure B-10. Annual relative abundance (fish/hr with SE bars), proportional size distribution (PSD), and relative size distribution (RSD-P) of largemouth bass captured by electrofishing during the spring in Clear Lake during 2005 - 2006 and 2009 - 2011. Mean catch per unit effort (CPUE) calculated for largemouth bass ≥ stock length (200 mm) only.

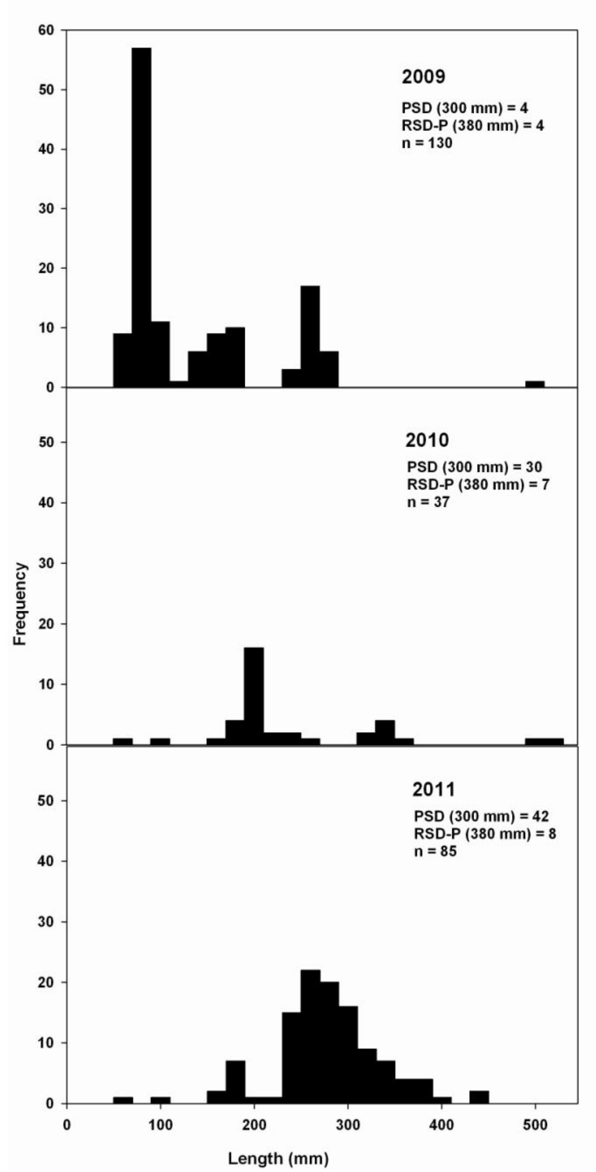


Figure B-11. Length frequency distribution (20-mm length groups) for largemouth bass captured by electrofishing during the spring in Clear Lake from 2009 to 2011.

Table B-5. Largemouth bass mean relative weight ($W_r$) with standard error (SE) in parenthesis by length category captured by electrofishing in Clear Lake from 1992 to 2011. Sampling occurred during fall from 1992 to 2004 and during the spring from 2005 to 2010.

| Year | ≥ Stock Overall $W_r$ | Stock - Quality (200-300 mm) (8-12 in) | Quality - Preferred (300-380 mm) (12-15 in) | Preferred - Memorable (380-510 mm) (15-20 in) | Memorable - Trophy (510-630 mm) (20-25 in) |
|---|---|---|---|---|---|
| 2011 | 105 (1.9) | 103 (1.9) | 107 (1.8) | 115 (3.2) | b |
| 2010 | 109 (4.7) | 98 (2.2) | 134 (13.6) | b | 120 (11.2) |
| 2009 | 154 (4.3) | 139 (2.3) | b | b | b |
| 2008 | a | a | a | a | a |
| 2007 | a | a | a | a | a |
| 2006 | 114 (2.9) | 102 (7.3) | b | b | b |
| 2005 | 116 (13.9) | 94 (11.4) | b | 137 (10.2) | b |
| 2004 | a | a | a | a | a |
| 2003 | b | b | b | b | b |
| 2002 | b | b | b | b | b |
| 2001 | 140 (5.8) | b | b | b | b |
| 2000 | 119 (9.6) | b | b | 119 (9.6) | b |
| 1999 | 136 (1.6) | 136 (1.6) | b | 122 (5.9) | b |
| 1998 | b | b | b | b | b |
| 1997 | b | b | b | b | b |
| 1996 | 180 (18.4) | 223 (4.8) | 127 (2.3) | b | b |
| 1995 | 120 (5.3) | b | 113 (7.8) | b | b |
| 1994 | 153 (2.1) | 153 (2.2) | b | 134 (1.2) | b |
| 1993 | 79 (13.6) | b | b | b | b |
| 1992 | 142 (4.6) | b | 138 (4.3) | 145 (9.20 | b |

a = Sampling did not occur or weights were not recorded during that year.
b = Category had less than two samples for mean and SE calculations, but may have been calculated in overall $W_r$.

## **Yellow perch**

Relative abundance of stock length yellow perch (≥ 130 mm) has remained low every year since 2003 (Figure B-12) while PSD and RSD-P have markedly declined from 2008 levels. Spawning success was evident in 2008 as the perch population in 2009 and 2010 was dominated by stock to quality length fish. The strong year class produced in 2004 has been nearly extirpated by angling, predation, or natural mortality (Figure B-13). Yellow perch mean $W_r$ in Clear Lake during 2011was the lowest since standardized surveys began in 1992 (Table B-6) and continues to be the lowest among the Refuge lakes surveyed for the second consecutive year. Like bluegills, yellow perch have demonstrated a noticeable decline in relative weights during 2010 and 2011. Relative abundance of black crappie has increased in Clear Lake, potentially increasing competition with bluegills for limited prey.

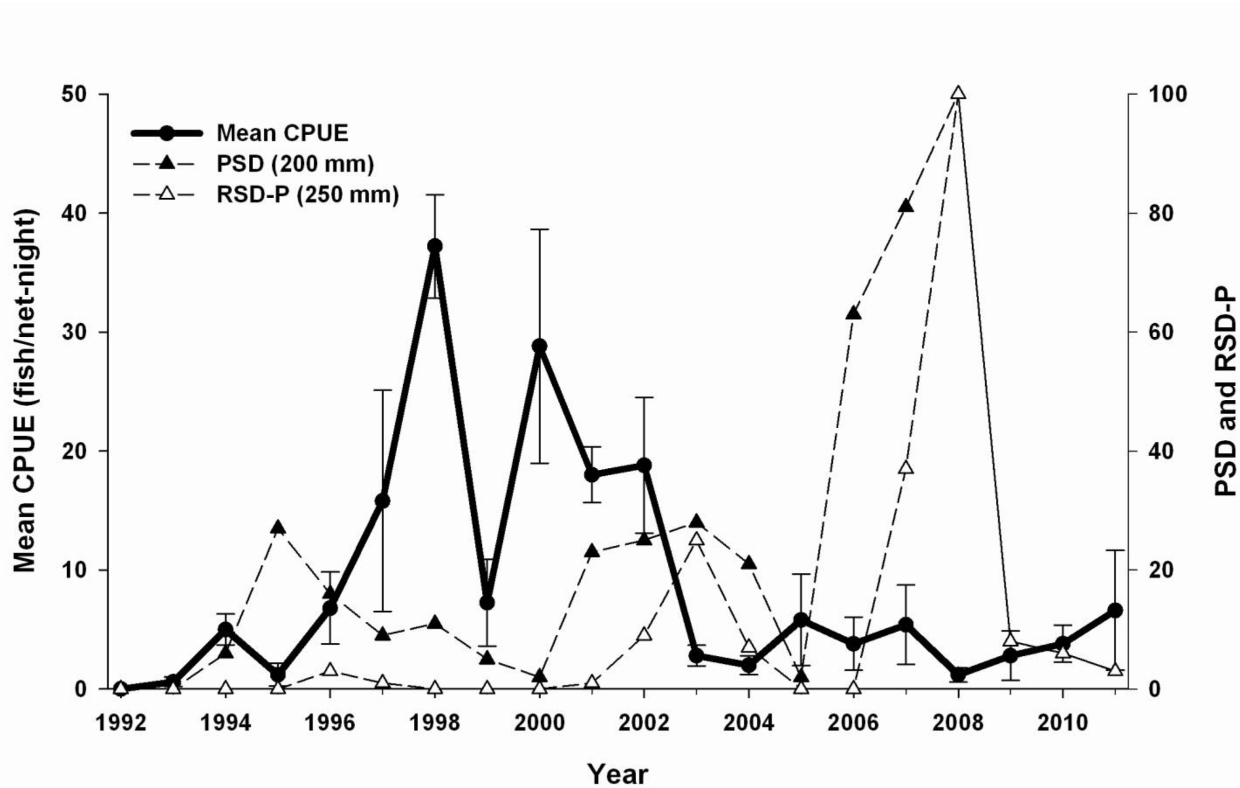


Figure B-12. Annual relative abundance (fish/net-night with SE bars), proportional size distribution (PSD), and relative size distribution (RSD-P) of yellow perch caught by gill nets in Clear Lake from 1992 to 2011. Mean catch per unit effort (CPUE) calculated for yellow perch ≥ stock length (130 mm) only.

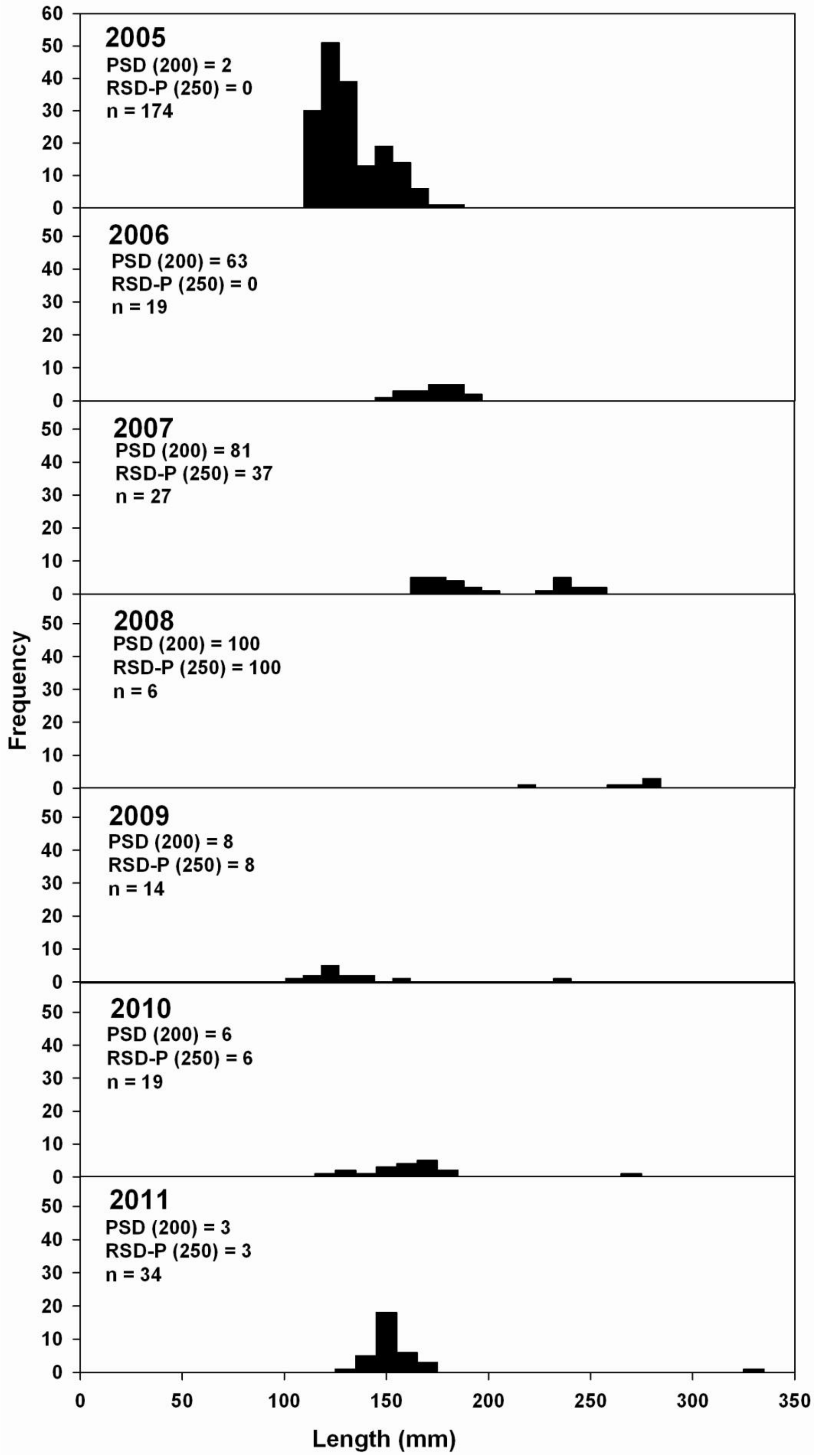


Figure B-13. Length frequency distribution (10-mm length groups) for yellow perch captured in gill nets during the fall in Clear Lake from 2005 to 2011.

Table B-6. Yellow perch mean relative weight ($W_r$) with standard errors (SE) in parenthesis by length category captured by gill nets in Clear Lake from 1992 to 2011.

| Year | ≥ Stock Overall $W_r$ | Stock - Quality (130-200 mm) (5-8 in) | Quality - Preferred (200-250 mm) (8-10 in) | Preferred - Memorable (250-300 mm) (10-12 in) | Memorable - Trophy (300-380 mm) (12-15 in) |
|---|---|---|---|---|---|
| 2011 | 77 (2.8) | 78 (2.9) | b | b | b |
| 2010 | 87 (3.5) | 87 (3.7) | b | b | b |
| 2009 | 90 (3.0) | 88 (3.0) | b | b | b |
| 2008 | 121 (3.6) | b | b | b | 119 (3.7) |
| 2007 | 93 (1.6) | 86 (2.9) | 93 (2.7) | 97 (1.5) | b |
| 2006 | 100 (2.4) | 108 (2.2) | 96 (2.9) | b | b |
| 2005 | 98 (2.0) | 98 (2.0) | 93 (2.7) | b | b |
| 2004 | 105 (7.6) | 110 (9.0) | 82 (8.0) | b | b |
| 2003 | 101 (2.2) | 101 (3.4) | b | 102 (1.6) | b |
| 2002 | 91 (1.2) | 87 (1.1) | 93 (2.4) | 100 (2.1) | 106 (4.8) |
| 2001 | 88 (1.3) | 92 (1.8) | 83 (1.4) | 80 (1.2) | b |
| 2000 | 94 (1.0) | 94 (1.1) | 94 (2.1) | b | b |
| 1999 | 93 (1.6) | 94 (1.8) | 88 (1.3) | b | b |
| 1998 | 103 (1.6) | 99 (1.9) | 111 (2.4) | 99 (2.9) | b |
| 1997 | 92 (1.7) | 93 (1.9) | 87 (4.2) | 91 (0.0) | b |
| 1996 | 96 (2.1) | 99 (2.9) | 93 (3.1) | 88 (7.1) | b |
| 1995 | 103 (7.4) | 107 (9.9) | 92 (1.9) | b | b |
| 1994 | 94 (2.3) | 91 (1.7) | 115 (4.2) | b | b |
| 1993 | 89 (4.2) | 89 (4.2) | b | b | b |
| 1992 | b | b | b | b | b |

a = Sampling did not occur or weights were not recorded during that year.
b = Category had less than two samples for mean and SE calculations, but may have been calculated in overall $W_r$.

# Summary

Common carp –Carp relative abundance is at its highest levels since sampling was initiated in 1992. Increased water levels have likely improved spawning, nursery, and foraging habitats for common carp in Clear Lake.

Northern pike – Relative abundance increased from 2010, but was not significantly different from all years since 1992. Clear Lake continued to have the highest abundance of preferred length (≥ 710 mm [28 in]) northern pike compared to Dewey and Pelican lakes.

Black crappie – Black crappies appear to be successfully spawning and recruiting in Clear Lake.

Bluegill – Electrofishing CPUE estimates for bluegill increased 2,550% from 2010 levels and the population continues to be dominated by stock to quality length fish (80 - 150 mm [3 - 6 in]). Mean relative weight for all fish ≥ stock length increased compared to 2010.

Largemouth bass – Electrofishing relative abundance of stock length largemouth bass increased ≥ 240% in Clear Lake the highest level seen in the last seven years. Nearly every year, largemouth bass have successfully spawned in Clear Lake, but few recruit to lengths preferred by anglers.

Yellow perch – A slight increase in relative abundance was observed compared to 2010 but relative abundance of yellow perch continued to remain low since 2003. For the second consecutive year, relative weights were the lowest observed since standardized surveys began in 1992.

## Management Recommendations

1. Continue the 28 in maximum size limit for northern pike. Encourage catch and release for northern pike to maintain and increase the adult population.

2. Continue to use Clear – Dewey ditch as a means for trapping and removing common carp.

3. Continue moving northern pike from West Long Lake to Clear Lake to supplement the adult population. Move northern pike from Watts Lake into Clear Lake. Watts Lake panfish populations will benefit from the mechanical removal of northern pike (Jolley et al. 2008).

4. Continue planning and development of a handicap accessible fishing dock/pier off the point just east of the boat ramp.

5. Add signs near lake access points to inform anglers of the illegal activity of moving fish from one lake to another.

6. Continue annual surveys.

# DEWEY LAKE

## Lake Description

Dewey Lake is accessible by gravel roads from County Highway 16B or U.S. Highway 83. The lake is heavily used during the ice fishing season when accessible. Angling pressure can also be heavy during spring and fall, but fishing pressure declines during summer when dense submergent vegetation covers much of the lake.

Dewey Lake is in the middle of a series of four lakes on the refuge connected by natural drainage or man-made ditches. A man made ditch connects Hackberry Lake (the first in the series) to Dewey Lake and another ditch connects Dewey Lake downstream to Clear Lake. The interconnection of these lakes has created problems with controlling inter-lake fish movement in past years.

Dewey Lake is 223 surface ha (560 acres) with a maximum depth of 2.7 m (8 ft) and a mean depth of 1.4 m (4 ft). A dike on the east end of Dewey Lake allows the water to be held about 1.3 m above natural pool. The surrounding shoreline is predominately grassland with few willows and cottonwoods. The west end of the lake has an organic bottom comprised of a broad area of littoral vegetation with small areas of open water. The lake bottom on the north-east edge is sandy and sparsely vegetated; the south-east edge has an organic bottom and is heavily vegetated with emergent vegetation such as cattails and bulrushes (*Scirpus spp.*). During summer, submergent and emergent vegetation is abundant in a band around the lake's edge and is often referred to as "weed choked". The bottom of Dewey Lake is relatively flat with few drop-offs or depressions. The lake is too shallow to develop a summer thermocline. Summer surface water temperatures often exceed 30 °C (80 °F) and dense algae blooms have been reported. Primary fish species include: yellow perch, northern pike, largemouth bass, bluegill, black bullhead, and common carp.

Dewey Lake was chemically renovated with rotenone in 1981 and restocked with game fish the following year (Appendix A). However, the renovation was either not 100% successful or common carp migrated into Dewey Lake from other lakes as a fisherman reported catching a carp in 1984. In the spring of 1993, large numbers of common carp were noted in the ditch between Dewey and White Water lakes, likely making an upstream spawning migration. These carp were removed with an estimated biomass of several tons. Large numbers of carp were also removed in 2008. Northern pike size restrictions changed four times from 1987 to 1993 (Appendix B) to improve their abundance and size structure in an effort to biologically control the common carp population.

Water quality parameters collected were water temperature, dissolved oxygen, pH, salinity, alkalinity, and conductivity (Table C-1). Additionally, water chemistry analysis was performed to determine nitrite, nitrate, total nitrogen, ammonia, ortho-phosphorous, and total phosphorous levels for Dewey Lake (Appendix I).

Table C-1. Dewey Lake surface water quality parameters from 1999 to 2011.

| Date | Time | Water temp. (°C) | D.O. (mg/L) | Secchi depth (cm) | pH | Salinity (ppt) | Phenolphthalein alkalinity (mg/L) | Total alkalinity (mg/L) | Conductivity (µS/cm) |
|---|---|---|---|---|---|---|---|---|---|
| 08/2011 | | 26 | 13.7 | 33 | 9.4 | | 17 | 120 | 274 |
| 08/2011 | | 26 | 16.9 | 61 | 9.5 | | | | 306 |
| 6/2011 | | 22 | 9.2 | | 8.6 | | 0 | 154 | 336 |
| 08/2010 | | 22 | 11.3 | | 9.7 | | 34 | 86 | 274 |
| 05/2010 | 0515 | 12 | 10.4 | | 8.5 | | 0 | 120 | 265 |
| 08/2009 | 1520 | 22 | 15.0 | | 9.8 | | 34 | 86 | 272 |
| 05/2009 | 1728 | 22 | 8.0 | 45 | 8.7 | | 0 | 170 | 323 |
| 09/2008 | | 21 | 20.4 | | 10.0 | 0.2 | 51 | 120 | 315 |
| 05/2008 | | 13 | 10.6 | | | 0.2 | 17 | 154 | 296 |
| 05/2007 | | 20 | 7.4 | | 7.4 | 0.2 | 0 | 205 | 304 |
| 08/2006 | | 21 | 11.7 | | 8.1 | 0.2 | 0 | 188 | 395 |
| 08/2005 | | 23 | | | 8.5 | | 0 | 240 | 320 |
| 09/2004 | | 20 | | 42 | 8.7 | | 0 | 139 | |
| 09/2003 | | 21 | 9.2 | | | | | | |
| 09/2002 | | 21 | 9.5 | | 9.8 | | 0 | 410 | 320 |
| 09/2001 | | 18 | | 66 | 7.0 | | 0 | 145 | 346 |
| 07/2001 | 1830 | 27 | 11.2 | | 7.3 | | 0 | 171 | |
| 07/2001 | 0645 | 23 | 7.2 | | 8.2 | | 0 | 154 | |
| 09/2000 | | 18 | | 60 | 9.5 | | 0 | 308 | 344 |
| 09/1999 | | 15 | | | 11.5 | | | | |

# Results and Discussion

## <u>Common carp</u>

Gill net mean CPUE increased slightly to 1.8 fish/net night in 2011 from 0.8 fish/net-night in 2010 (Figure C-1). Additionally, spring trap net CPUE also increased slightly (Figure C-2). The last apparent evidence of successful spawning of common carp in Dewey Lake was in 2008; however, that year class was not detected in 2009 – 2011 trap nets or gill nets indicating likely low recruitment to the population (Figure C-3). The common carp population is dominated with large adult individuals. The Nebraska state record common carp (50 pounds 5 ounces) was taken from Dewey Lake on 13 June 2010 with a bow and arrow.

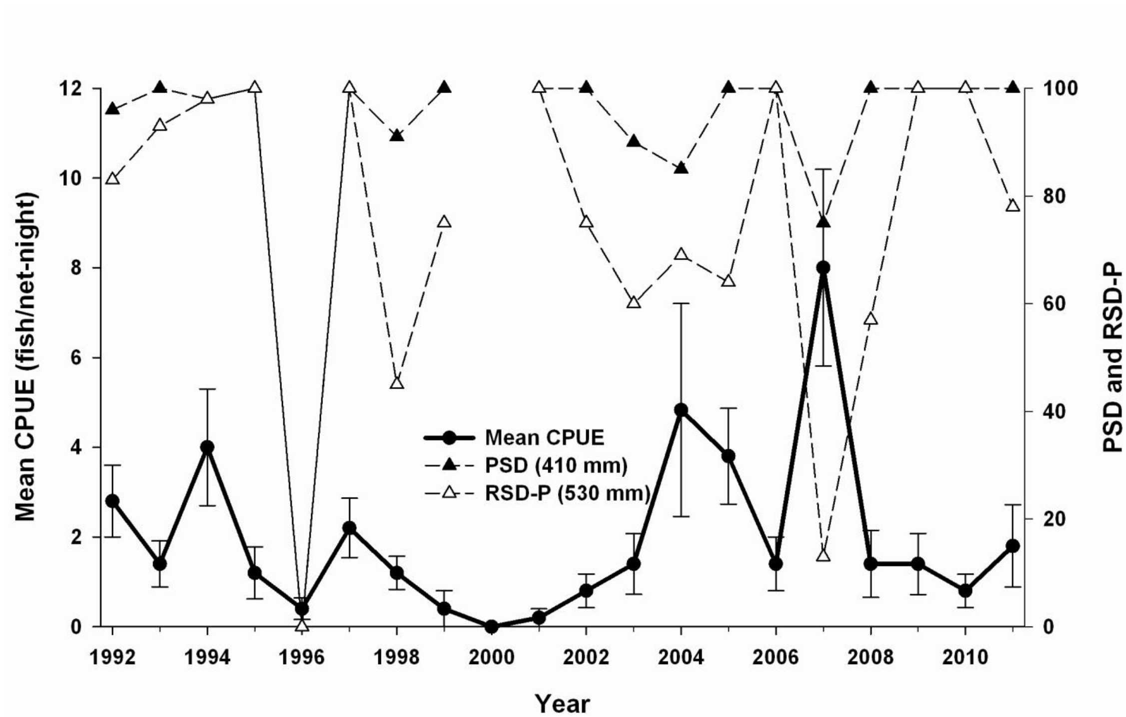


Figure C-1. Annual relative abundance (fish/net-night with SE bars), proportional size distribution (PSD), and relative size distribution (RSD-P) of common carp caught by gill nets during the fall in Dewey Lake from 1992 to 2011. Mean catch per unit effort (CPUE) calculated for common carp ≥ stock length (280 mm) only.

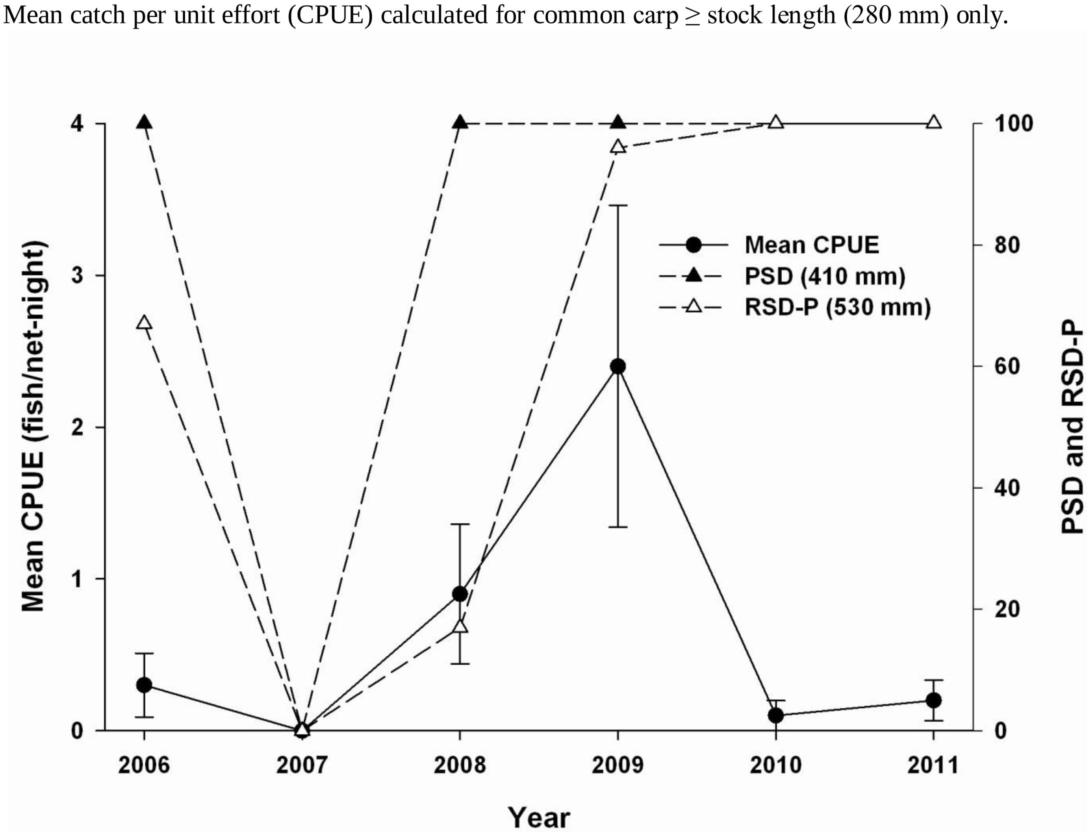


Figure C-2. Annual relative abundance (fish/net-night with SE bars), proportional size distribution (PSD), and relative size distribution (RSD-P) of common carp captured by trap nets during the spring in Dewey Lake from 2006-2011. Mean catch per unit effort (CPUE) calculated for common carp ≥ stock length (280 mm) only.

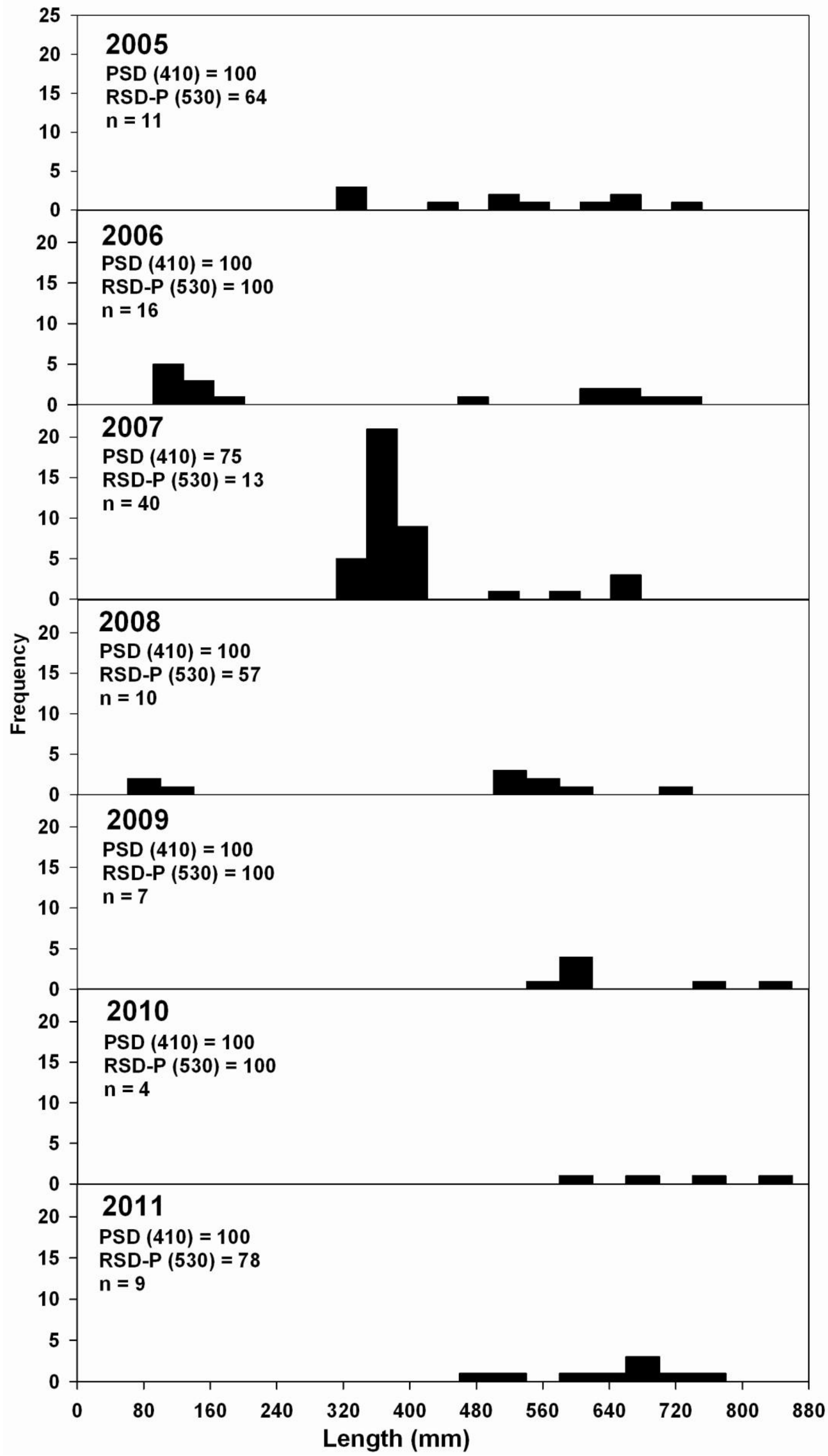


Figure C-3. Length frequency distribution (40-mm length groups) of common carp captured in gill nets during the fall in Dewey Lake from 2005 to 2011.

## Northern pike

Relative abundance of northern pike increased in 2011 to its highest level since 2006 based on trap net relative abundance (Figure C-4) and was the highest of the five refuge lakes sampled in 2011. Gill net CPUE also increased from 2010 levels (Figure C-5) but was statistically similar to all previous years (1992 – 2010) except 2004. During 2011 the northern pike population was dominated by quality and preferred length fish (Figures C-6 and C-7). Mean $W_r$ for northern pike ≥ quality length was highest in Dewey Lake compared to Pelican and Watts lakes during 2010 and 2011 (Table C-2).

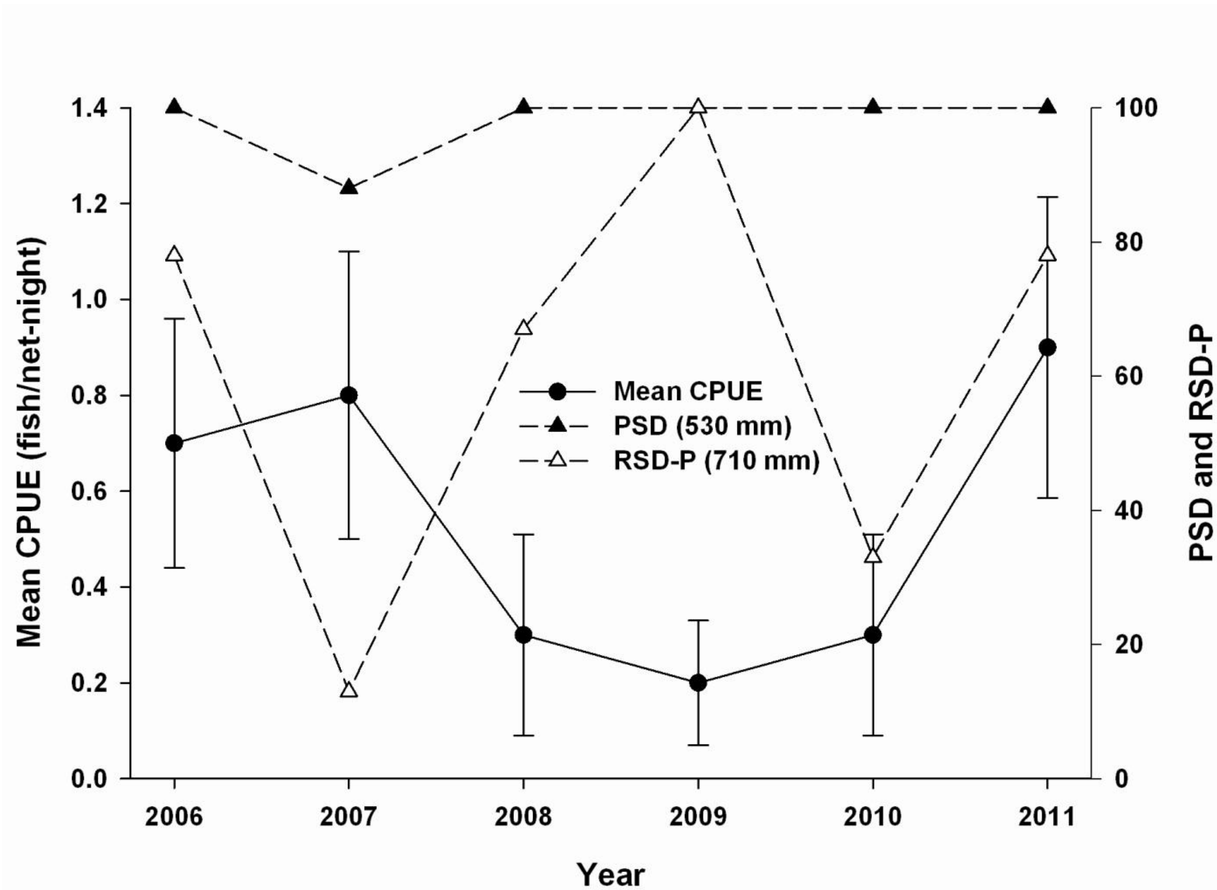


Figure C-4. Annual relative abundance (fish/net-night with SE bars), proportional size distribution (PSD), and relative size distribution (RSD-P) of northern pike captured by trap nets during the spring in Dewey Lake from 2006-2011. Mean catch per unit effort (CPUE) calculated for northern pike ≥ stock length (350 mm) only.

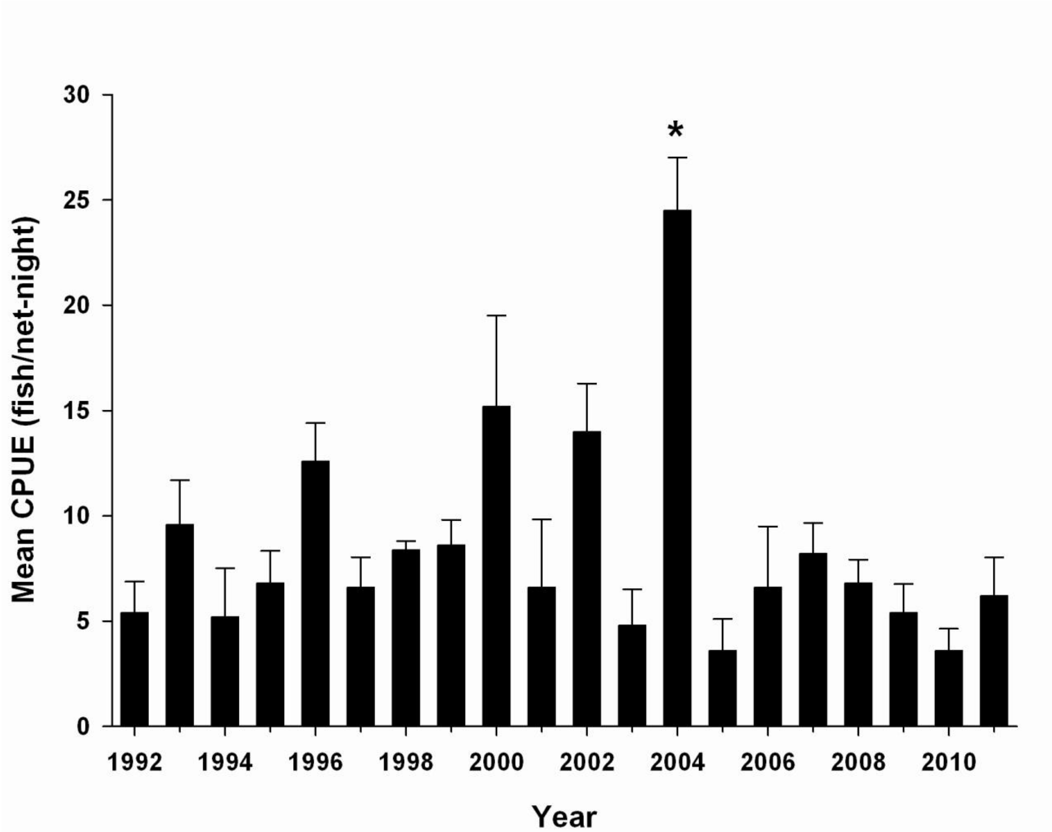


Figure C-5. Northern pike gill net mean catch per unit effort (CPUE) with SE bars for Dewey Lake from 1992 to 2011. Years with an asterisk are significantly different (P < 0.20) from 2011 using ANOVA with Tukey-Kramer multiple comparison tests.

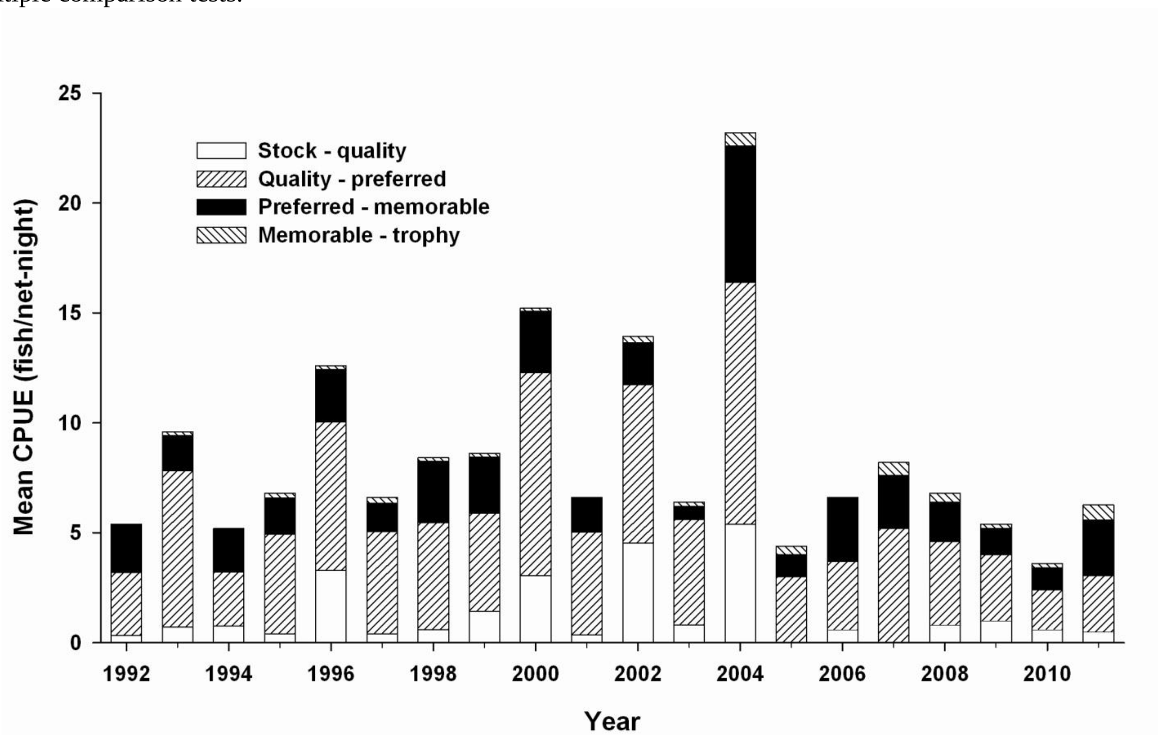


Figure C-6. Gill-net mean catch per unit effort (CPUE) for northern pike by length category in Dewey Lake from 1992 to 2011.

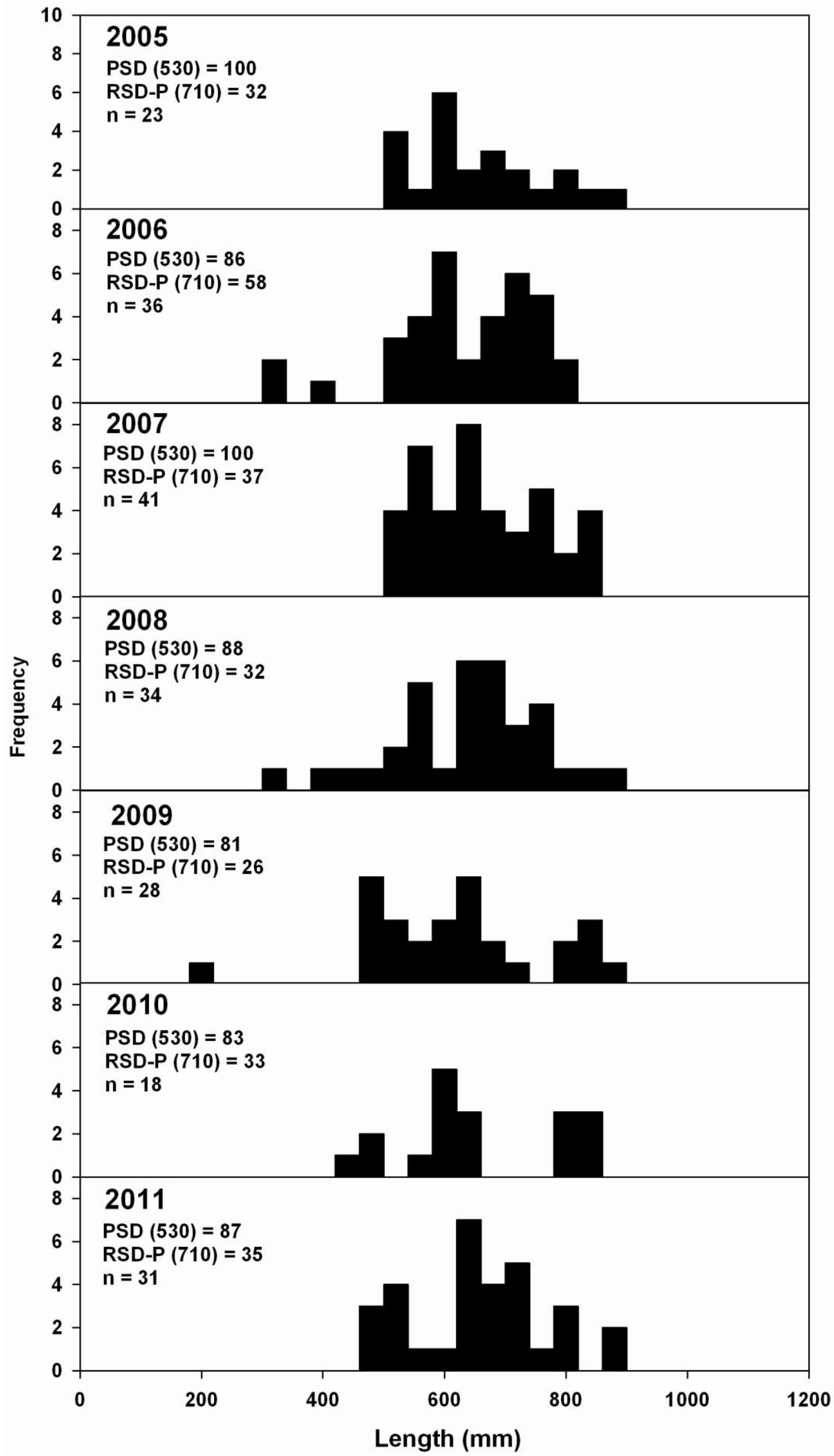


Figure C-7. Length frequency distribution (40-mm length groups) for northern pike captured in gill nets during the fall in Dewey Lake from 2005 to 2011.

Table C-2. Population size structure, traditional proportional size distribution (PSD) and incremental relative size distribution (RSD) with relative weights ($W_r$) of northern pike in Dewey Lake, Valentine NWR during the fall. 2006 to 2011 data for fall gill netting only. Data are pooled for trap nets and gill nets from 1987 to 2005. Data are summarized by length categories with 80 % confidence intervals (+/-; Gustafson 1988).

| Year | % ≥ Quality | | Stock - Quality (350-530mm) (14-21 in) | | | Quality to Preferred (530-710mm) (21-28 in) | | | Preferred to memorable (710-860mm) (28-34 in) | | | Memorable to trophy (860-1120mm) (34-44 in) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PSD | $W_r$ | RSD | +/- | $W_r$ | RSD | +/- | $W_r$ | RSD | +/- | $W_r$ | RSD | +/- | $W_r$ |
| 2011 | 92 | 93 | 8 | a | 96 | 41 | 13 | 94 | 41 | 13 | 92 | 11 | a | 85 |
| 2010 | 83 | 96 | 17 | a | 133 | 50 | 19 | 94 | 28 | a | 86 | 6 | a | 94 |
| 2009 | 81 | 94 | 19 | 13 | 99 | 56 | 16 | 97 | 22 | 13 | 87 | 5 | a | 77 |
| 2008 | 88 | 93 | 12 | 15 | 96 | 56 | 20 | 94 | 26 | 18 | 94 | 6 | a | 86 |
| 2007 | 100 | 100 | 0 | a | | 63 | 16 | 104 | 29 | a | 95 | 7 | a | 81 |
| 2006 | 91 | 98 | 9 | a | 133 | 47 | a | 111 | 44 | 22 | 76 | 0 | a | |
| 2005 | 100 | 89 | 0 | a | a | 100 | a | 93 | 32 | a | 81 | 9 | a | 78 |
| 2004 | 79 | 97 | 21 | 11 | 98 | 47 | 9 | 103 | 27 | 11 | 92 | 3 | a | 88 |
| 2003 | 88 | 94 | 12 | a | 104 | 75 | 12 | 94 | 9 | a | 89 | 3 | a | 86 |
| 2002 | 62 | 84 | 38 | 13 | 80 | 40 | 12 | 87 | 19 | a | 88 | 3 | a | 89 |
| 2001 | 95 | 95 | 5 | a | 109 | 71 | 99 | 90 | 24 | 10 | 85 | 0 | a | |
| 2000 | 80 | 90 | 20 | 9 | 87 | 62 | 7 | 71 | 17 | 6 | 79 | 1 | a | 84 |
| 1999 | 78 | 91 | 22 | 7 | 88 | 52 | 10 | 91 | 30 | 9 | 94 | 2 | a | 91 |
| 1998 | 89 | 92 | 11 | 7 | 90 | 54 | 10 | 92 | 33 | 9 | 92 | 2 | a | 80 |
| 1997 | 87 | 100 | 13 | 8 | 105 | 63 | 10 | 102 | 25 | 9 | 96 | 5 | a | 99 |
| 1996 | 69 | 103 | 31 | 9 | 101 | 48 | 11 | 105 | 19 | 9 | 104 | 1 | a | 96 |
| 1995 | 93 | 107 | 7 | 9 | 122 | 61 | 12 | 107 | 28 | 11 | 106 | 4 | 9 | 103 |
| 1994 | 86 | 103 | 14 | 9 | 115 | 47 | 12 | 103 | 38 | 12 | 97 | 0 | a | |
| 1993 | 92 | 98 | 8 | 9 | 111 | 71 | 8 | 99 | 21 | a | 98 | 0 | a | |
| 1992 | 94 | 85 | 6 | 8 | 100 | 51 | 9 | 85 | 43 | 8 | 83 | 0 | a | |
| 1991 | 95 | 88 | 5 | a | 94 | 59 | a | 91 | 36 | a | 86 | 0 | a | |
| 1990 | 96 | 90 | 4 | a | 84 | 72 | a | 87 | 24 | a | 93 | 0 | a | |
| 1989 | 88 | 103 | 12 | a | 95 | 65 | a | 97 | 19 | a | 102 | 4 | a | 109 |
| 1988 | 85 | 110 | 15 | a | 110 | 75 | a | 105 | 10 | a | 105 | 0 | a | |
| 1987 | 17 | 110 | 83 | a | 95 | 12 | a | 90 | 5 | a | 96 | 0 | a | |

a = Confidence intervals could not be calculated due to small sample size.

## Black bullhead

No black bullheads were collected in 2011. During 2010 a single black bullhead was captured in the spring trap net (224 mm) and one in fall gill net (222 mm). Seven black bullhead that ranged in length from 79 to 181 mm (mean = 143 mm; SD = 35.5) were captured in trap nets during spring 2009. During 2008, three fish were collected in trap nets, of similar length to 2009, which was the first year black bullheads were detected in Dewey Lake since 1997.

## Bluegill

Relative abundance of bluegills in Dewey Lake substantially increased since the highs in 2006 and 2007 based on electrofishing (Figure C-8) and trap net (Figure C-9) indices. Both indices indicate a ≥ 1,337% increase in relative abundance compared to 2010. Electrofishing CPUE of bluegill ≥ stock length was the highest among refuge lakes sampled in 2011. The size structure in 2011 indicates an increase in the number of fish < 80 mm, highlighting successful recruitment of a 2010 year class (Figure C-10). Mean $W_r$ for bluegill ≥ stock length (Table C-3) remains similar to previous years and other Refuge lakes indicating an abundance of prey.

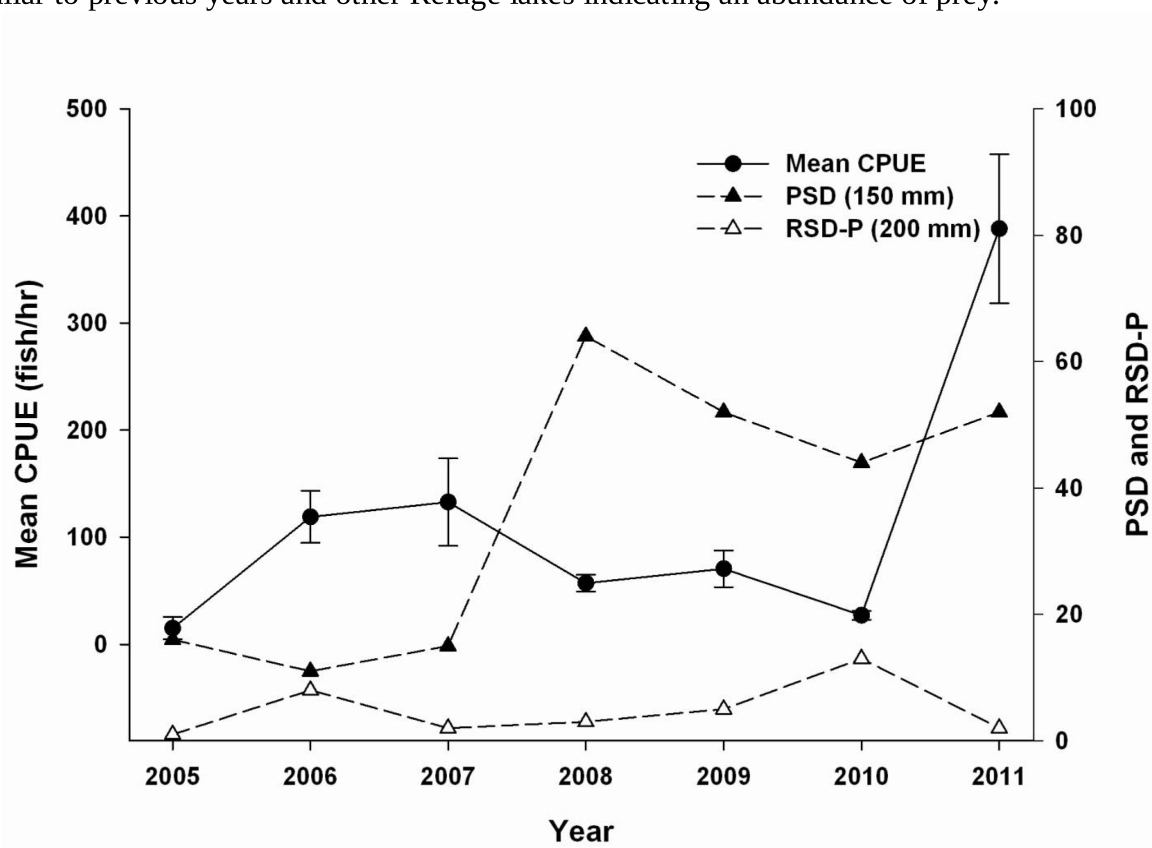


Figure C-8. Annual relative abundance (fish/hr), proportional size distribution (PSD), and relative size distribution (RSD-P) of bluegills captured by electrofishing during the spring in Dewey Lake from 2005 to 2011. Mean catch per unit effort (CPUE) calculated for bluegill ≥ stock length (80 mm) only.

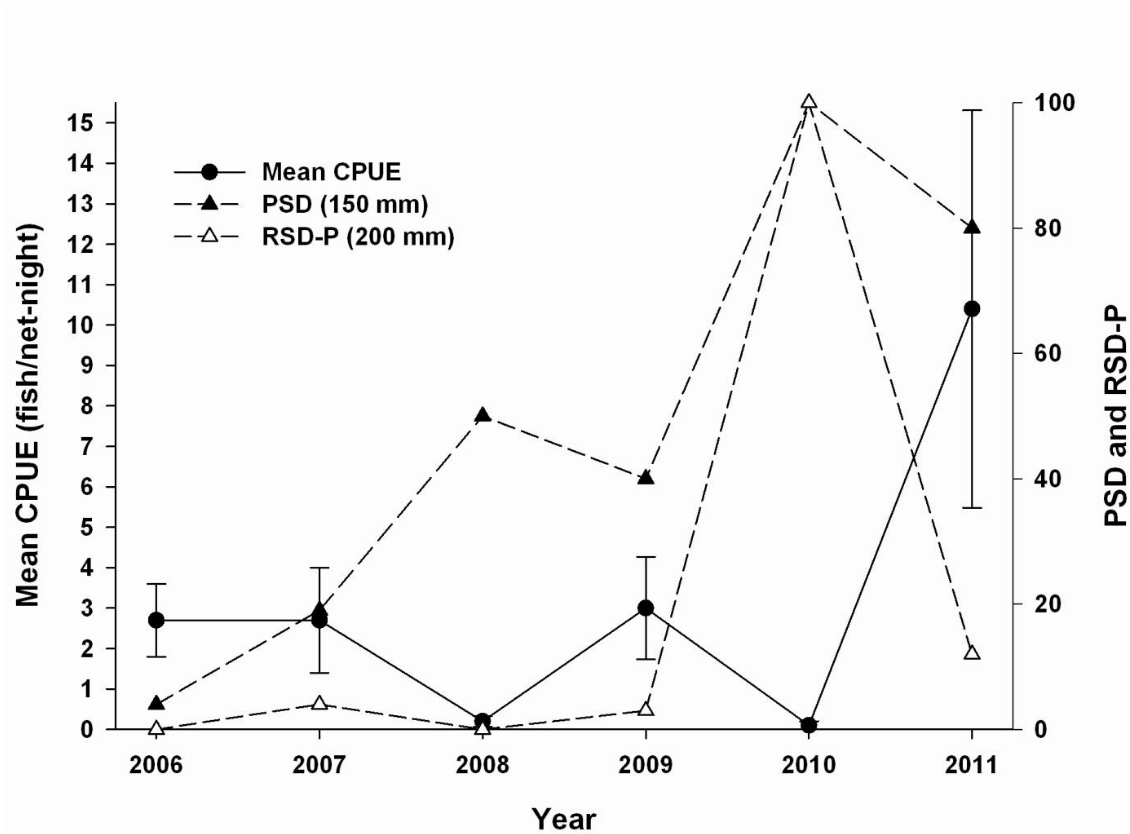


Figure C-9. Annual relative abundance (fish/net-night), proportional size distribution (PSD), and relative size distribution (RSD-P) of bluegills captured by trap nets during the spring in Dewey Lake from 2006 to 2011. Mean catch per unit effort (CPUE) calculated for bluegill ≥ stock length (80 mm) only.

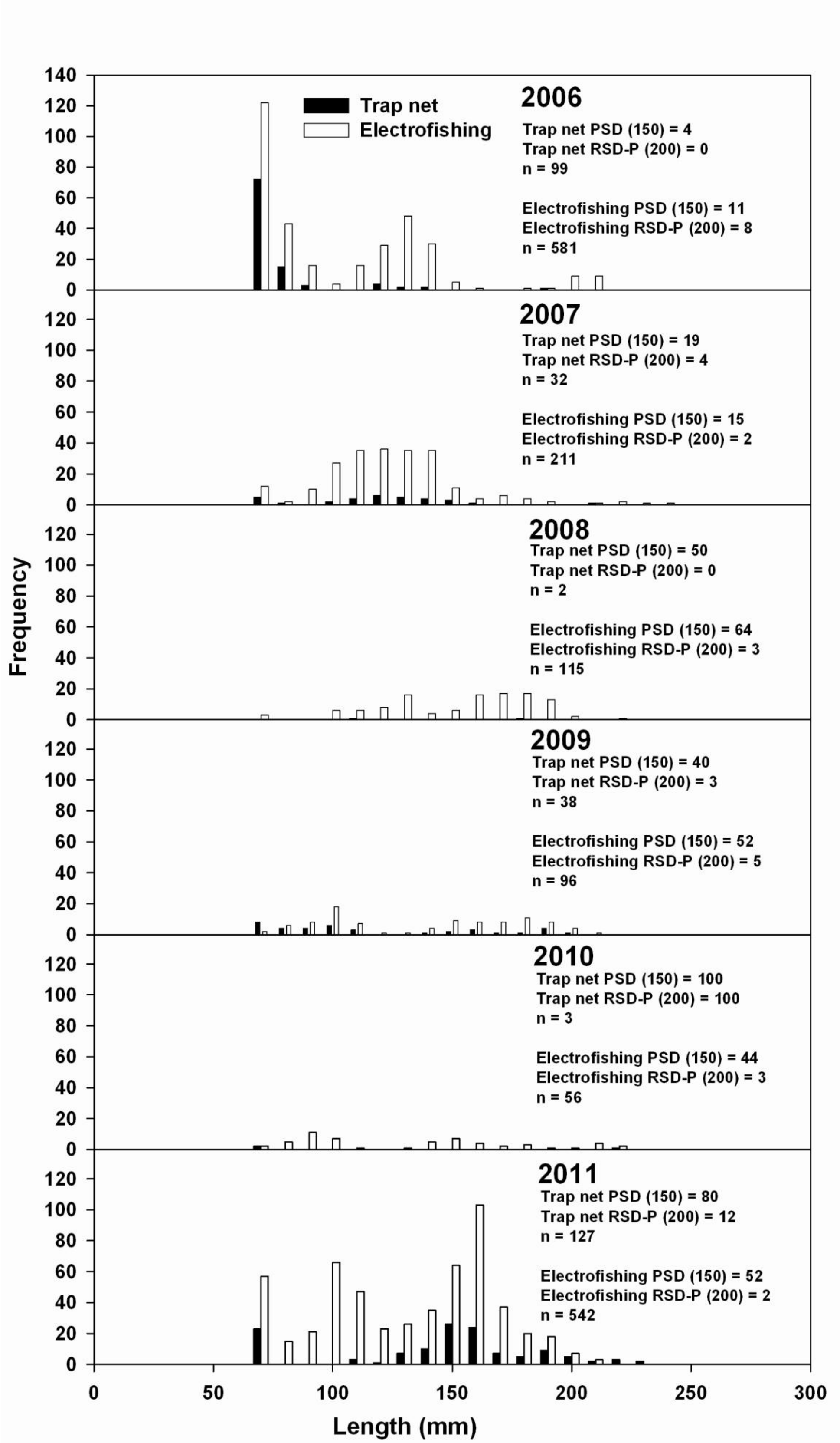


Figure C-10. Length frequency distribution (10-mm length groups) for bluegill captured by trap nets (black bars) and electrofishing (white bars) during the spring in Dewey Lake from 2006 to 2011.

Table C-3. Bluegill mean relative weight ($W_r$) with standard error (SE) in parenthesis by length category captured by electrofishing and trap nets in Dewey Lake from 1992 to 2011. Sampling occurred during fall from 1992 to 2004 and during the spring from 2005 to 2011.

| Year | ≥ Stock Overall $W_r$ | Stock - Quality (80-150 mm) (3-6 in) | Quality - Preferred (150-200 mm) (6-8 in) | Preferred - Memorable (200-250 mm) (8-10 in) | Memorable - Trophy (250-300 mm) (10-12 in) |
|---|---|---|---|---|---|
| 2011 | 119 (1.1) | 118 (1.8) | 123 (1.8) | 116 (2.3) | b |
| 2010 | 115 (2.3) | 108 (3.7) | 121 (2.5) | 121 (4.9) | b |
| 2009 | a | a | a | a | a |
| 2008 | 120 (1.7) | 118 (2.8) | 122 (2.2) | 117 (6.8) | b |
| 2007 | 122 (2.1) | 125 (2.7) | 118 (3.7) | 116 (5.2) | b |
| 2006 | 120 (1.5) | 119 (1.7) | 126 (3.1) | 119 (4.9) | b |
| 2005 | 114 (1.5) | 115 (1.8) | 113 (2.6) | b | b |
| 2004 | 117 (1.4) | 114 (1.7) | 119 (2.2) | 128 (2.1) | b |
| 2003 | 115 (2.1) | 116 (2.6) | 115 (3.8) | b | b |
| 2002 | 115 (1.4) | 115 (1.9) | 117 (2.1) | b | b |
| 2001 | 118 (2.9) | 118 (3.1) | b | 111 (4.5) | b |
| 2000 | 114 (2.2) | 111 (4.0) | 118 (2.2) | 114 (3.5) | b |
| 1999 | 124 (1.7) | 123 (2.0) | 124 (6.4) | 123 (1.7) | b |
| 1998 | 119 (2.1) | 118 (3.4) | 123 (3.2) | 109 (3.6) | b |
| 1997 | 115 (1.5) | 116 (2.7) | 114 (1.9) | 119 (4.8) | b |
| 1996 | 121 (1.9) | 123 (3.1) | 119 (1.9) | 117 (2.1) | b |
| 1995 | 120 (2.2) | 116 (1.6) | 138 (9.5) | 129 (6.0) | b |
| 1994 | 125 (2.7) | 115 (3.0) | 140 (2.3) | 147 (0.5) | b |
| 1993 | 114 (2.5) | 119 (3.2) | 106 (3.3) | b | b |
| 1992 | 108 (1.3) | 107 (1.6) | 112 (2.9) | 115 (1.4) | b |

a = Sampling did not occur or weights were not recorded during that year.
b = Category had less than two samples for mean and SE calculations, but may have been calculated in overall $W_r$.

## Largemouth bass

Mean relative abundance of largemouth bass sampled from electrofishing increased 416% in 2011 compared to 2010 (Figure C-11). Largemouth bass electrofishing CPUE for Dewey Lake is one of the lowest among the refuge lakes sampled during 2011, being tied with Hackberry. The presence of fish < stock length indicates successful recruitment of a 2010 year class into 2011 (Figure C-12). Mean $W_r$ of largemouth bass ≥ stock length was the highest among Refuge lakes sampled in 2011 (Table C-4).

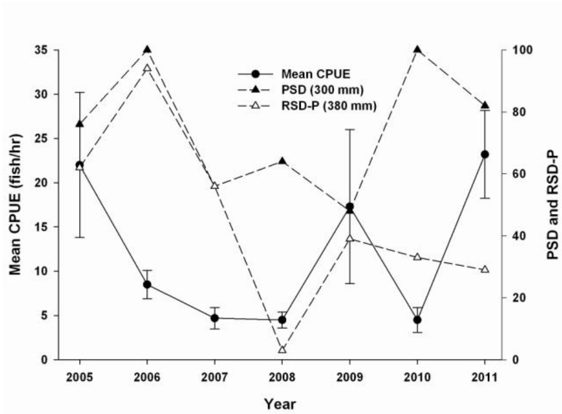


Figure C-11. Annual relative abundance (fish/hr with SE bars), proportional size distribution (PSD), and relative size distribution (RSD-P) of largemouth bass captured by electrofishing during the spring in Dewey Lake from 2005 to 2011. Mean catch per unit effort (CPUE) calculated for largemouth bass ≥ stock length (200 mm) only.

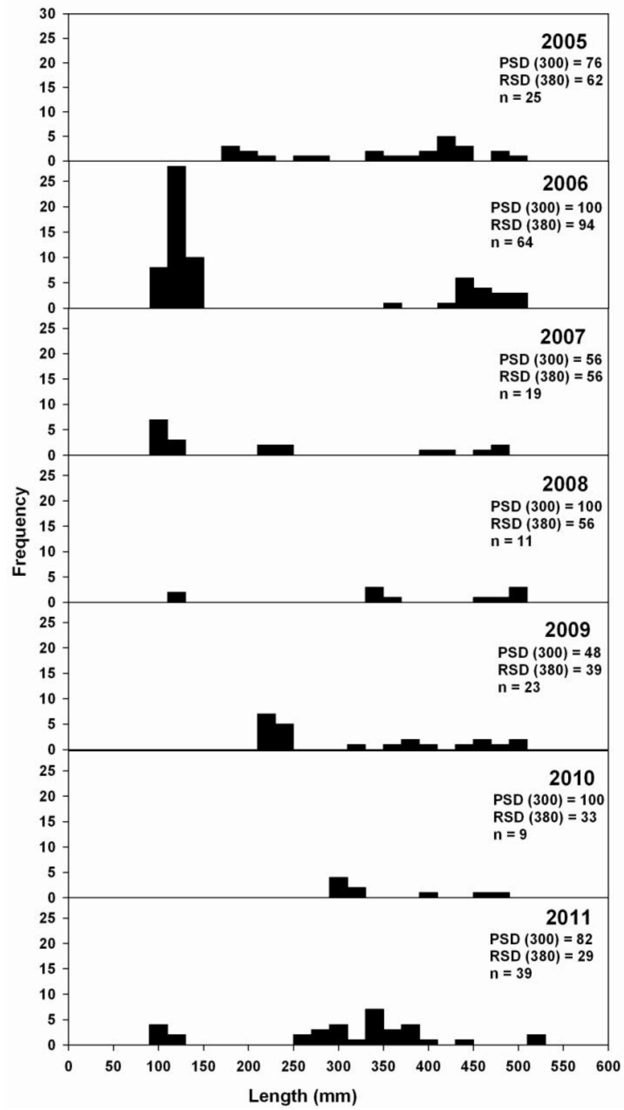


Figure C-12. Length frequency distribution (20-mm length groups) for largemouth bass captured by electrofishing during the spring in Dewey Lake from 2005 to 2011.

Table C-4. Largemouth bass mean relative weight ($W_r$) with standard error (SE) in parenthesis by length category captured by electrofishing in Dewey Lake from 1992 to 2011. Sampling occurred during fall from 1992 to 2004 and during the spring from 2005 to 2011.

| Year | ≥ Stock<br>Overall $W_r$ | Stock - Quality (200-300 mm) (8-12 in) | Quality - Preferred (300-380 mm) (12-15 in) | Preferred - Memorable (380-510 mm) (15-20 in) | Memorable - Trophy (510-630 mm) (20-25 in) |
|---|---|---|---|---|---|
| 2011 | 109 (2.2) | 108 (2.2) | 110 (3.7) | 109 (3.9) | 106 (9.3) |
| 2010 | 124 (4.6) | | 124 (6.5) | 125 (6.7) | b |
| 2009 | 121 (4.2) | 130 (3.2) | 80 (36.9) | 119 (3.6) | b |
| 2008 | 125 (2.2) | b | 129 (2.8) | 129 (3.7) | 121 (4.2) |
| 2007 | 129 (4.0) | 115 (2.2) | b | 135 (5.8) | b |
| 2006 | 108 (3.3) | b | b | 108 (4.2) | 119 (1.7) |
| 2005 | 135 (2.2) | 128 (4.0) | 142 (2.7) | 135 (3.0) | b |
| 2004 | 130 (2.1) | 130 (3.3) | 122 (4.1) | 132 (2.9) | b |
| 2003 | 117 (13.7) | b | b | b | b |
| 2002 | 127 (2.5) | 129 (4.1) | b | 125 (3.3) | b |
| 2001 | b | b | b | b | b |
| 2000 | 118 (4.0) | 123 (3.7) | 100 (7.1) | 122 (5.7) | b |
| 1999 | 131 (1.6) | 131 (2.0) | 128 (2.5) | b | b |
| 1998 | b | b | b | b | b |
| 1997 | 93 (1.1) | 130 (2.6) | b | 131 (10.7) | b |
| 1996 | 135 (2.3) | 138 (2.6) | 133 (3.4) | 117 (5.6) | b |
| 1995 | 137 (3.4) | 137 (3.6) | b | b | b |
| 1994 | 154 (6.4) | 110 (1.9) | 163 (9.2) | 146 (3.8) | b |
| 1993 | 131 (8.4) | 122 (3.3) | 141 (15.2) | b | b |
| 1992 | 106 (12.5) | 106 (12.5) | b | b | b |

a = Sampling did not occur or weights were not recorded during that year.
b = Category had less than two samples for mean and SE calculations, but may have been calculated in overall $W_r$.

## **Yellow perch**

Mean relative abundance of yellow perch collected in trap nets was the lowest among refuge lakes, decreasing to 0.0 fish/net night during 2011 (Figure C-13), while mean CPUE in gill nets increased 16% from 2010 (Figure C-14). Multiple year classes of yellow perch were evident based on modes in the length frequency (Figure C-15) with no recruitment by the 2010 year class evident. Mean $W_r$ for fish ≥ stock length was highest in Dewey Lake among the refuge lakes sampled in 2011(Table C-5).

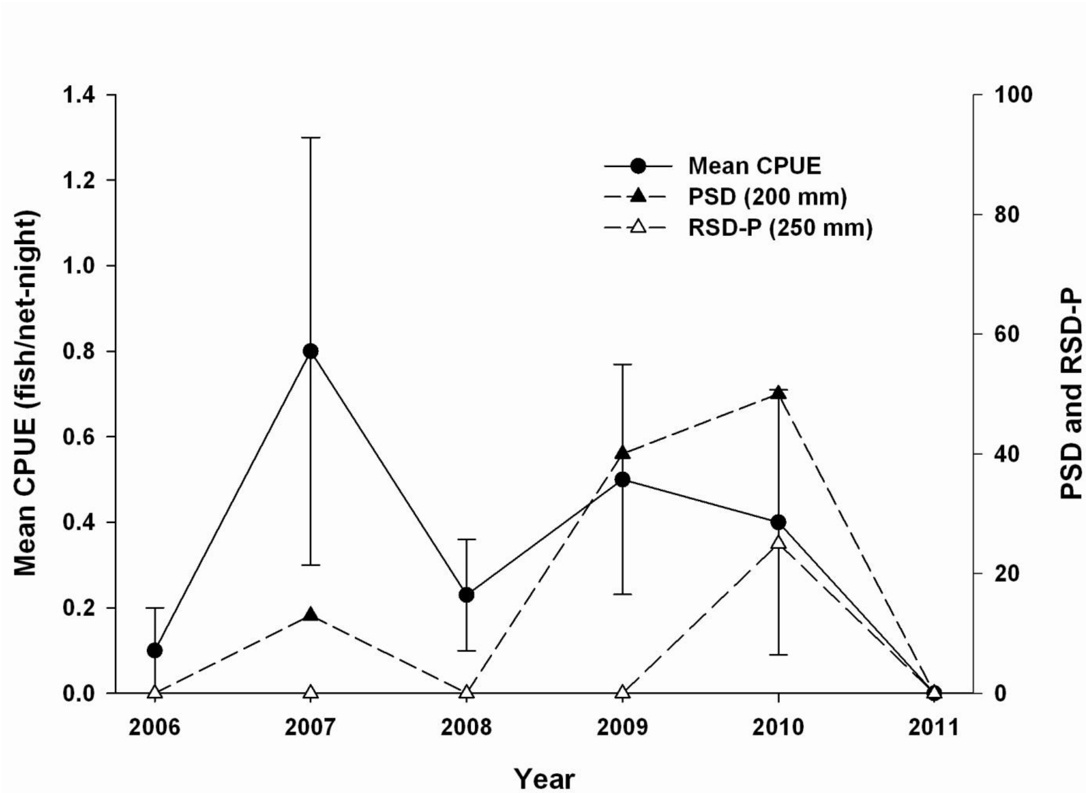


Figure C-13. Annual relative abundance (fish/net-night with SE bars), proportional size distribution (PSD), and relative size distribution (RSD-P) of yellow perch captured by trap nets during the spring in Dewey Lake from 2006 to 2011. Mean catch per unit effort (CPUE) calculated for perch ≥ stock length (130 mm) only.

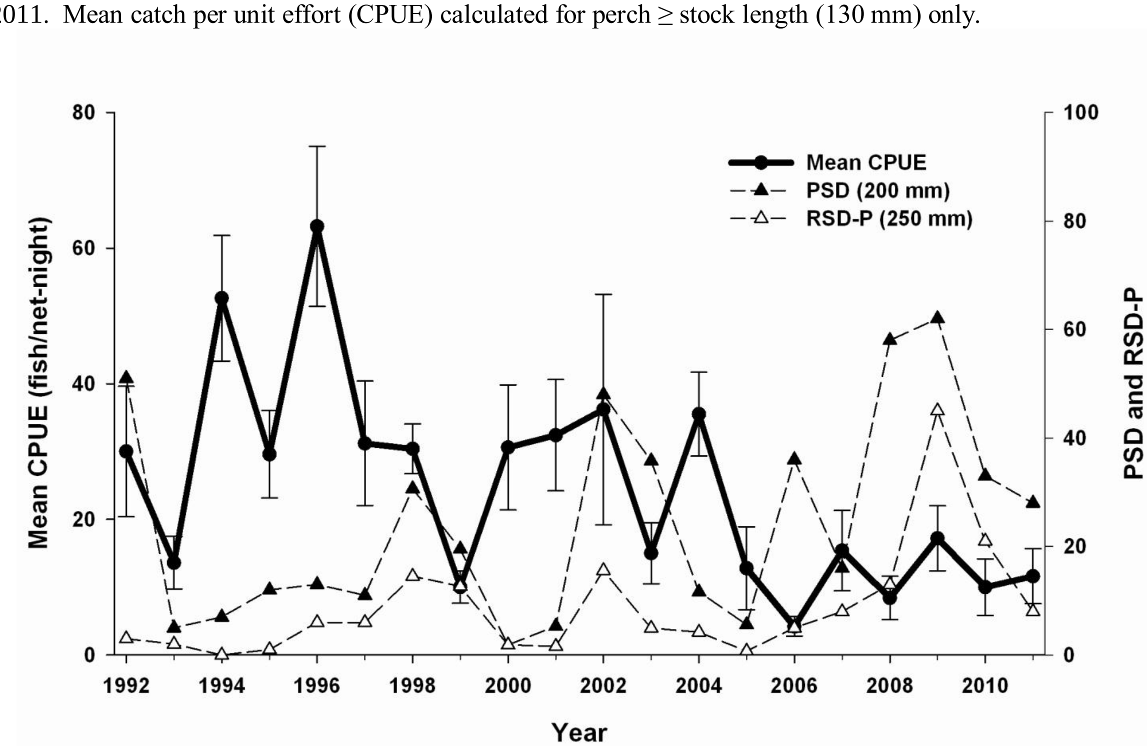


Figure C-14. Annual relative abundance (fish/net-night with SE bars), proportional size distribution (PSD), and relative size distribution (RSD-P) of yellow perch captured by gill nets during the fall in Dewey Lake from 1992 to 2011. Mean catch per unit effort (CPUE) calculated for perch ≥ stock length (130 mm) only.

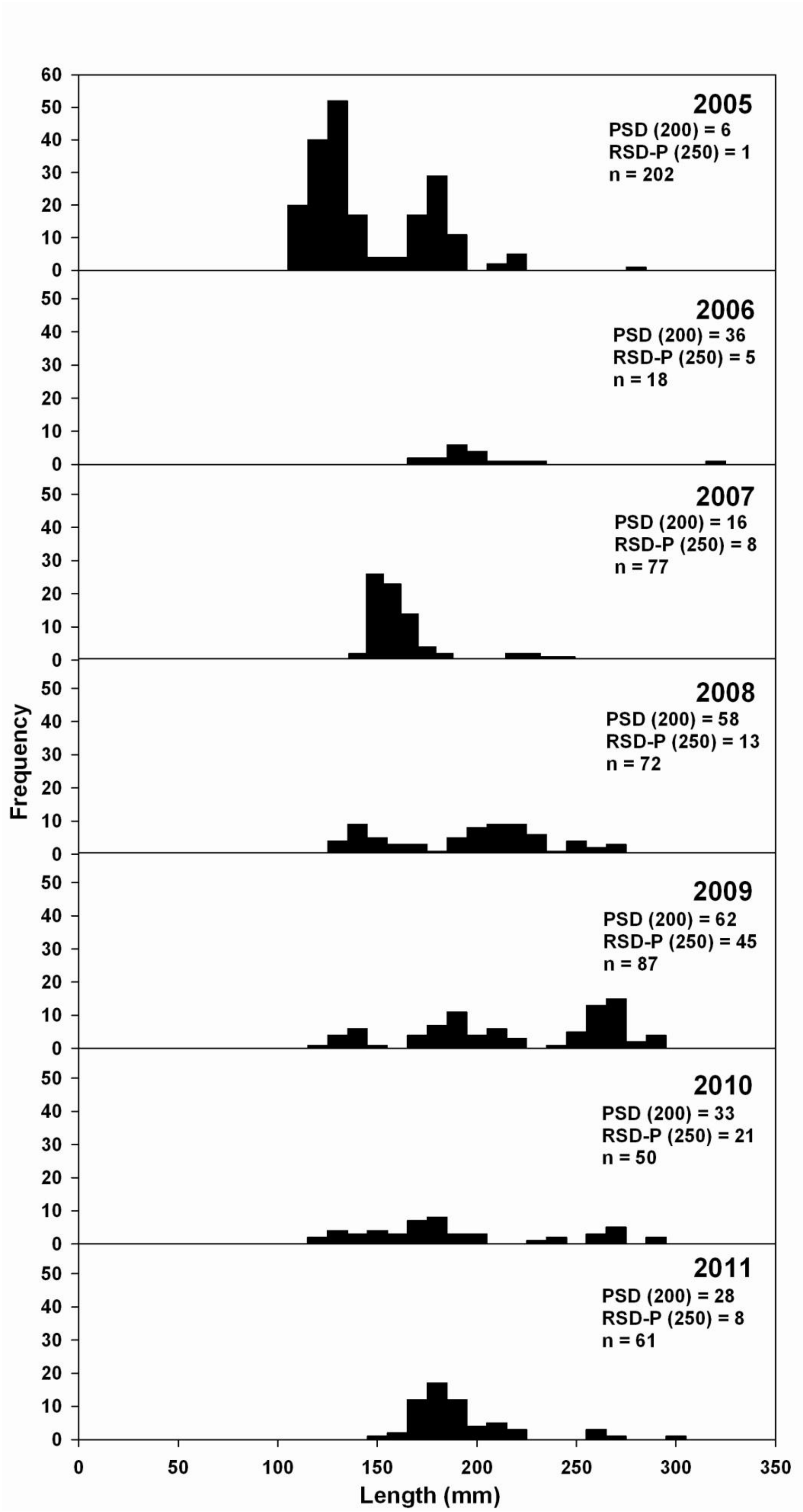


Figure C-15. Length frequency distribution (10-mm length groups) of yellow perch captured in gill nets during the fall in Dewey Lake from 2005 to 2011.

Table C-5. Yellow perch mean relative weight ($W_r$) with standard error (SE) in parenthesis by length category captured by gill nets during the fall in Dewey Lake from 1992 to 2011.

| Year | ≥ Stock<br>Overall $W_r$ | Stock - Quality<br>(130-200 mm)<br>(5-8 in) | Quality - Preferred<br>(200-250 mm)<br>(8-10 in) | Preferred - Memorable<br>(250-300 mm)<br>(10-12 in) | Memorable - Trophy<br>(300-380 mm)<br>(12-15 in) |
|---|---|---|---|---|---|
| 2011 | 100 (1.8) | 98 (2.8) | 102 (2.2) | 108 (5.4) | b |
| 2010 | 101 (1.9) | 103 (2.6) | 98 (3.8) | 93 (2.0) | b |
| 2009 | 99 (1.0) | 98 (1.3) | 102 (2.4) | 97 (1.5) | b |
| 2008 | 94 (1.5) | 94 (2.0) | 98 (2.3) | 86 (3.5) | b |
| 2007 | 98 (1.9) | 102 (2.0) | 92 (3.8) | 87 (4.2) | b |
| 2006 | 94 (2.5) | 116 (5.2) | 95 (3.8) | b | b |
| 2005 | 96 (0.9) | 97 (1.0) | 93 (1.2) | b | b |
| 2004 | 97 (2.1) | 88 (2.1) | 106 (5.0) | 100 (2.6) | b |
| 2003 | 101 (2.0) | 97 (1.6) | 104 (5.3) | 110 (3.6) | b |
| 2002 | 98 (1.2) | 97 (2.1) | 102 (1.5) | 103 (2.3) | b |
| 2001 | 115 (1.4) | 95 (2.1) | 82 (3.4) | b | 101 (3.7) |
| 2000 | 92 (1.3) | 93 (1.30 | b | 86 (4.6) | 84 (0.1) |
| 1999 | 99 (1.2) | 96 (1.4) | 105 (2.3) | 102 (2.8) | 108 (3.8) |
| 1998 | 99 (1.0) | 95 (1.1) | 103 (2.0) | 103 (2.3) | 101 (2.1) |
| 1997 | 106 (2.0) | 102 (1.5) | 112 (7.0) | 111 (2.7) | 109 (1.2) |
| 1996 | 102 ( 1.4) | 99 (1.4) | 107 (2.6) | 103 (3.8) | 100 (1.5) |
| 1995 | 106 (0.9) | 103 (1.2) | 109 (1.2) | 106 (2.9) | b |
| 1994 | 109 (1.5) | 108 (2.1) | 110 (1.9) | b | b |
| 1993 | 108 (2.8) | 111 (2.7) | 85 (8.7) | 98 (8.5) | b |
| 1992 | 98 (1.3) | 100 (2.3) | 96 (1.8) | 94 (2.3) | 102 (6.3) |

a = Sampling did not occur or weights were not recorded during that year.
b = Category had less than two samples for mean and SE calculations, but may have been calculated in overall $W_r$.

# Summary

Common carp – Relative abundance remained low and was dominated by large adults. The last strong year class was evident in 2006.

Northern pike – Trap net mean relative abundance in Dewey Lake was the highest among refuge lakes sampled in 2011. Catch per unit effort of fish ≥ stock length was statistically similar to the past six years, while the number of fish captured in the quality, preferred, and memorable length classes increased compared to 2010.

Bluegill –Trap net and electrofishing CPUE increased during 2011 compared to 2010. Despite few preferred length fish found in the population, multiple year classes are progressing through the population.

Largemouth bass – The relative abundance of largemouth bass in Dewey Lake was among the lowest of Refuge lakes sampled in 2011. The 2010 year class will help to balance the size structure that appears to be dominated by fish ≥ 205 mm.

Yellow perch – Multiple year classes were evident providing increased angling opportunities. Condition of yellow perch increased with increase in length.

## Management Recommendations

1. Continue the 28 in maximum size limit for northern pike. Encourage catch and release for northern pike to maintain and increase the adult population.

2. Continue to use Dewey - Whitewater ditch as a means for trapping and removing common carp.

3. Control water levels in Dewey Lake to improve fish spawning habitat. This may need to be performed every other year to produce strong year classes those years.

4. Add signs near lake access points to inform anglers of the illegal activity of moving fish from one lake to another.

5. Continue annual surveys.

# HACKBERRY LAKE

## Lake Description

Hackberry Lake is adjacent to the Refuge's headquarters and is easily accessible from State Highway 16B. This lake receives heavy fishing pressure during winters when other refuge trails and fishing lakes are inaccessible. Angling is greatest during the ice fishing season through late spring/early summer and then declines as the lake becomes heavily vegetated.

Hackberry Lake is the first in a series of four lakes on the refuge that are connected by natural drainage or man-made ditches. In high water years, a water control structure between Hackberry and Dewey lakes (the next lake downstream) controls water levels in Hackberry. During the spring and summer of 1995-1997, lake levels were near record highs and many lakes and creeks were connected. These connections allowed common carp migration.

Hackberry Lake is 275 surface ha (680 ac). Maximum and mean depths are 1.8 m (5 ft.) and 1.0 m (3 ft.), respectively. The lake bottom is relatively flat and highly organic. The lake is too shallow to thermally stratify. Abundant decaying organic matter has reduced dissolved oxygen levels to less than 1 ppm during winters with extended ice cover resulting in periodic winter-kills. Summer-kills have also been noted but are usually less severe. Emergent vegetation (cattail and bulrush) dominates the entire lake edge. Because the lake is shallow, heavily vegetated, and relatively alkaline, dense algae blooms are common and likely contribute to the periodic summer fish kills. During summer, the entire lake is essentially a large littoral area with dense submergent vegetation. Specific conductivity averages 407 µS/cm, total alkalinity averages 204 mg/L, phenolphthalein alkalinity averages 38 mg/L, pH ranges from 8.5 during winter/spring to 10 during summer. Secchi disk averages 0.3 m during summer. The surrounding watershed consists of mixed grass sandhills, which are lightly grazed by cattle.

Hackberry Lake has a history of high common carp abundance. In 2004, the Refuge and NGPC cooperated in a joint effort to lower Hackberry Lake and chemically renovate the fishery. Draw down began in August of 2004 and the lake was chemically renovated using rotenone. By October 2004, Hackberry Lake was declared carp free and fish stockings were initiated during the fall of 2004 with additional stockings since (Appendix A). The last chemical renovation prior to 2004 was conducted in 1975. Hackberry Lake was presumed to be carp free until carp were captured during the 1988 surveys. From 1988 to 1992, Hackberry Lake was identified as the "control lake" for evaluating northern pike as a biological agent for controlling carp recruitment and followed state size and bag limits. During January 1992, the 36 in (910 mm) northern pike minimum size limit was extended to include Hackberry Lake. During the 1992 northern pike spawning operation, approximately 1,000 northern pike collected from Pelican Lake were transferred to Hackberry Lake to increase the northern pike population. Beginning January 1993, regulations were implemented to allow the harvest of northern pike 28 in or less (Appendix B). The primary fish species in Hackberry Lake are largemouth bass, yellow perch, bluegill, northern pike, and common carp.

Historical surface water quality parameters are reported in Table D-1. Additionally, water chemistry analysis was performed to determine nitrite, nitrate, total nitrogen, ammonia, ortho-phosphorous, and total phosphorous levels for Hackberry Lake (Appendix I).

Table D-1. Hackberry Lake surface water quality parameters.

| Date | Time | Water temp. (°C) | D.O. (mg/L) | Secchi depth (cm) | pH | Salinity (ppt) | Phenolphthalein alkalinity (mg/L) | Total alkalinity (mg/L) | Conductivity (µS/cm) |
|---|---|---|---|---|---|---|---|---|---|
| 08/2011 | | 22 | 6.8 | 78 | 8.9 | | 0 | 171 | 388 |
| 06/2011 | | 19 | 9.5 | | 9.0 | | 0 | 171 | 369 |
| 08/2010 | 1630 | 23 | 11.3 | | 9.1 | | 0 | 154 | 370 |
| 05/2010 | 2200 | 12 | 9.3 | | 8.6 | | 0 | 171 | 351 |
| 08/2009 | 0900 | 22 | 6.0 | | 8.2 | | 0 | 171 | 392 |
| 05/2009 | 2100 | 22 | 11.8 | 120 | 9.1 | | 34 | 153 | 403 |
| 09/2008 | | 19 | 11.9 | | 8.8 | 0.22 | 0 | 222 | 402 |
| 05/2008 | | | 7.7 | | | 0.2 | 0 | 205 | 345 |
| 08/2002 | | 20 | 11.0 | | 9.7 | | 137 | 393 | 430 |
| 09/2001 | | 18 | | 75 | 7.2 | | 8 | 154 | 368 |
| 07/2001 | 1915 | 28 | 12.0 | | 7.1 | | 17 | 137 | |
| 07/2001 | 0745 | 23 | 4.0 | | 8.0 | | 17 | 137 | |
| 09/2000 | | 18 | | 30 | 8.5 | | 10 | 200 | 425 |
| 09/1999 | | 16 | | | 7.1 | | | | |

# Results and Discussion

## Common carp

Common carp gill net mean CPUE substantially declined in 2010 and 2011 compared to 2008 and 2009 (Figure D-1). Trap net mean CPUE substantially increased from 2009 to 2011 (Figure D-2) and was the highest among the four large lakes (Clear, Dewey, Hackberry, and Pelican) sampled for the third consecutive year. Common carp were first detected in Hackberry Lake in 2008 since the renovation in 2004. Based on lengths (Figure D-3), it appeared that most, if not all fish are from a single year class, likely > age-4 based on lengths of fish captured (Coulter et al. 2008).

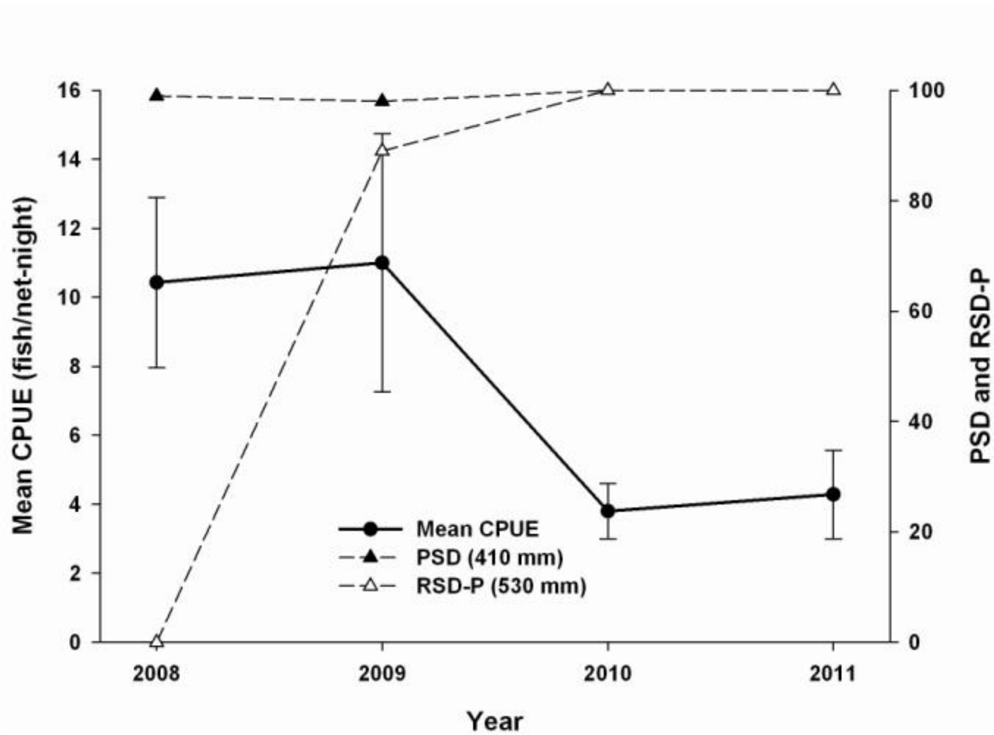


Figure D-1. Annual relative abundance (fish/net-night with SE bars), proportional size distribution (PSD), and relative size distribution (RSD-P) of common carp caught by gill nets during the fall in Hackberry Lake from 2008 to 2011. Mean catch per unit effort (CPUE) calculated for common carp ≥ stock length (280 mm) only.

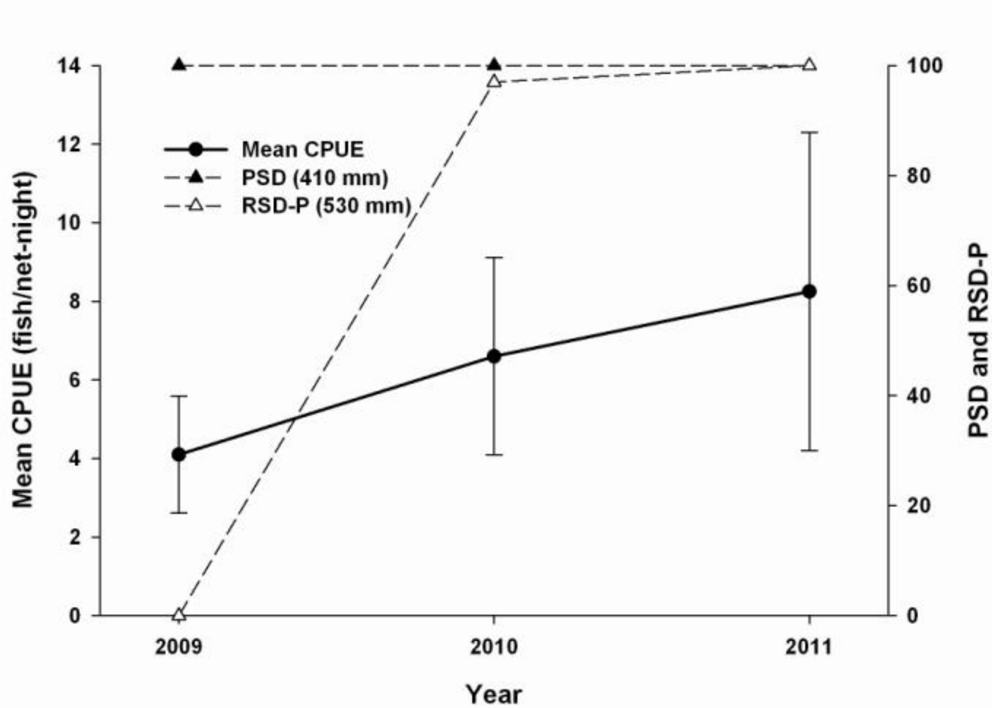


Figure D-2. Annual relative abundance (fish/net-night with SE bars), proportional size distribution (PSD), and relative size distribution (RSD-P) of common carp caught by trap nets during the spring in Hackberry Lake from 2009 to 2011. Mean catch per unit effort (CPUE) calculated for common carp ≥ stock length (280 mm) only.

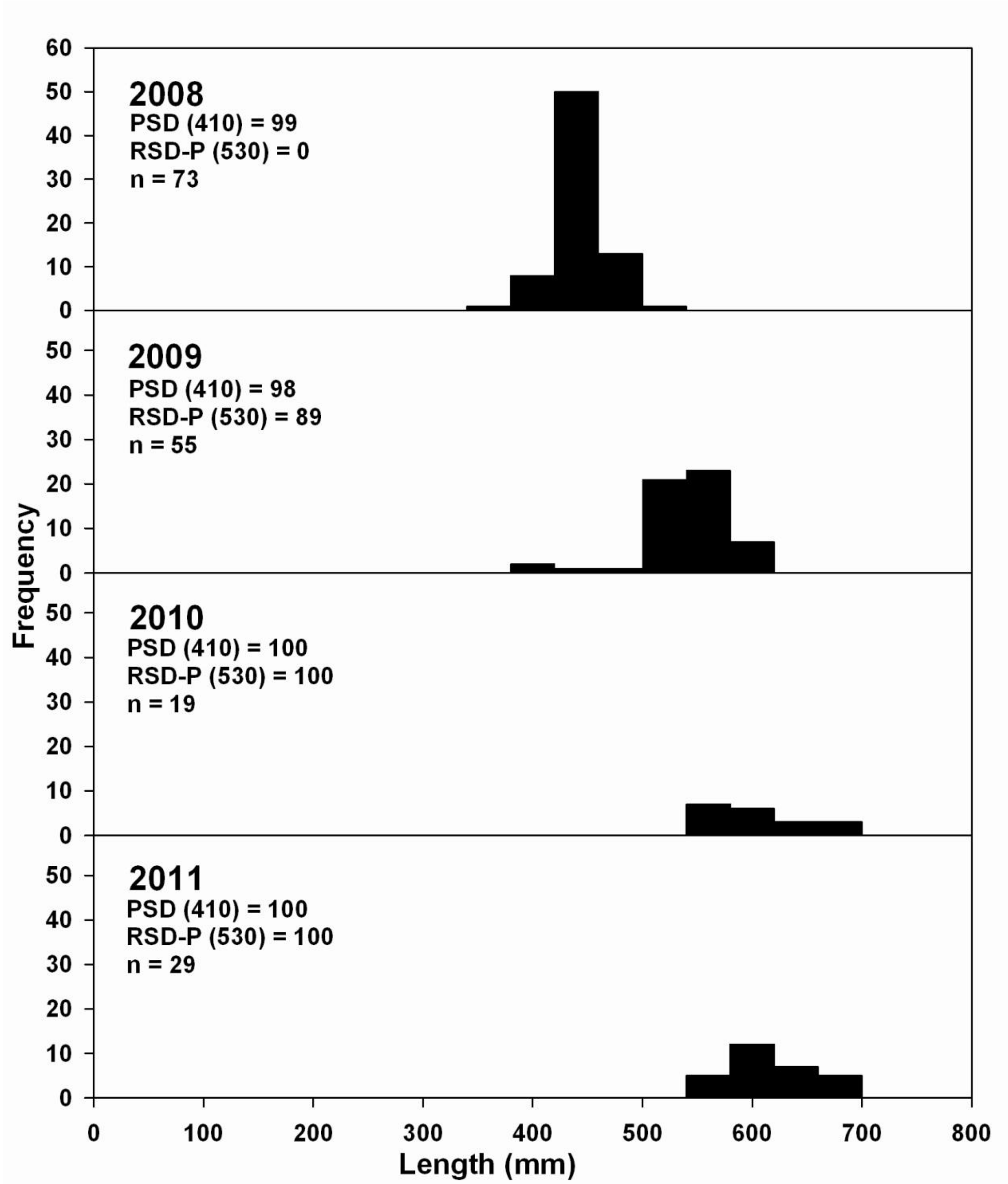

Figure D-3. Length frequency distribution (40-mm length groups) of common carp captured in gill nets in Hackberry Lake from 2008 to 2011.

## Northern pike

After the renovation in 2004, the first detection of northern pike occurred during the 2008 spring electrofishing survey. Northern pike relative abundance has increased each year following renovation (Figure D-4). In gill nets, northern pike lengths ranged from 297 to 2550 mm, PSD = 50, and RSD-P = 33 in 2011. Mean $W_r$ for stock-length fish was 84, for quality-length fish was 93, and trophy-length fish 90, while mean $W_r$ for fish ≥ stock fish was 87. A single northern pike 330 mm in length was captured in trap nets during 2011, providing evidence of natural reproduction or illegal stocking.

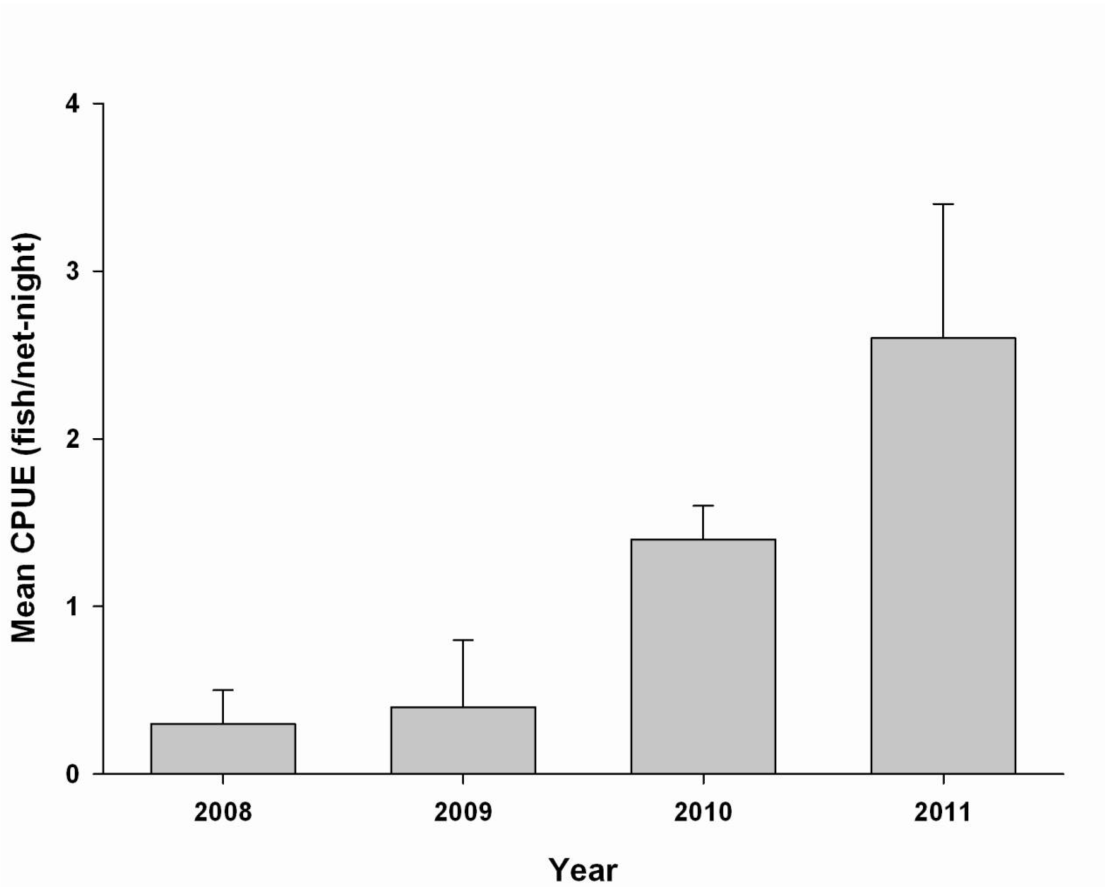

Figure D-4. Northern pike gill net mean catch per unit effort (CPUE) with SE bars for Hackberry Lake from 2008 to 2011.

**Bluegill**

The stocking of nearly 180,000 bluegills in 2007 and 52,000 fish in 2008 was successful. Bluegill relative abundance increased in Hackberry Lake from 2006 to 2009; however, mean CPUE declined in 2010. Electrofishing relative abundance increased 162% in 2011 when compared to 2010 (Figure D-5). A balanced size structure for bluegills was found in Hackberry Lake with many fish reaching preferred length in 2011 (Figure D-6). Mean $W_r$ was highest among lakes sampled for all bluegill ≥ stock, quality – preferred length, and preferred – memorable length fish in 2011 (Table D-2). Bluegill abundance, in combination with larger sized fish in excellent condition, should make Hackberry Lake a destination for anglers in the short-term.

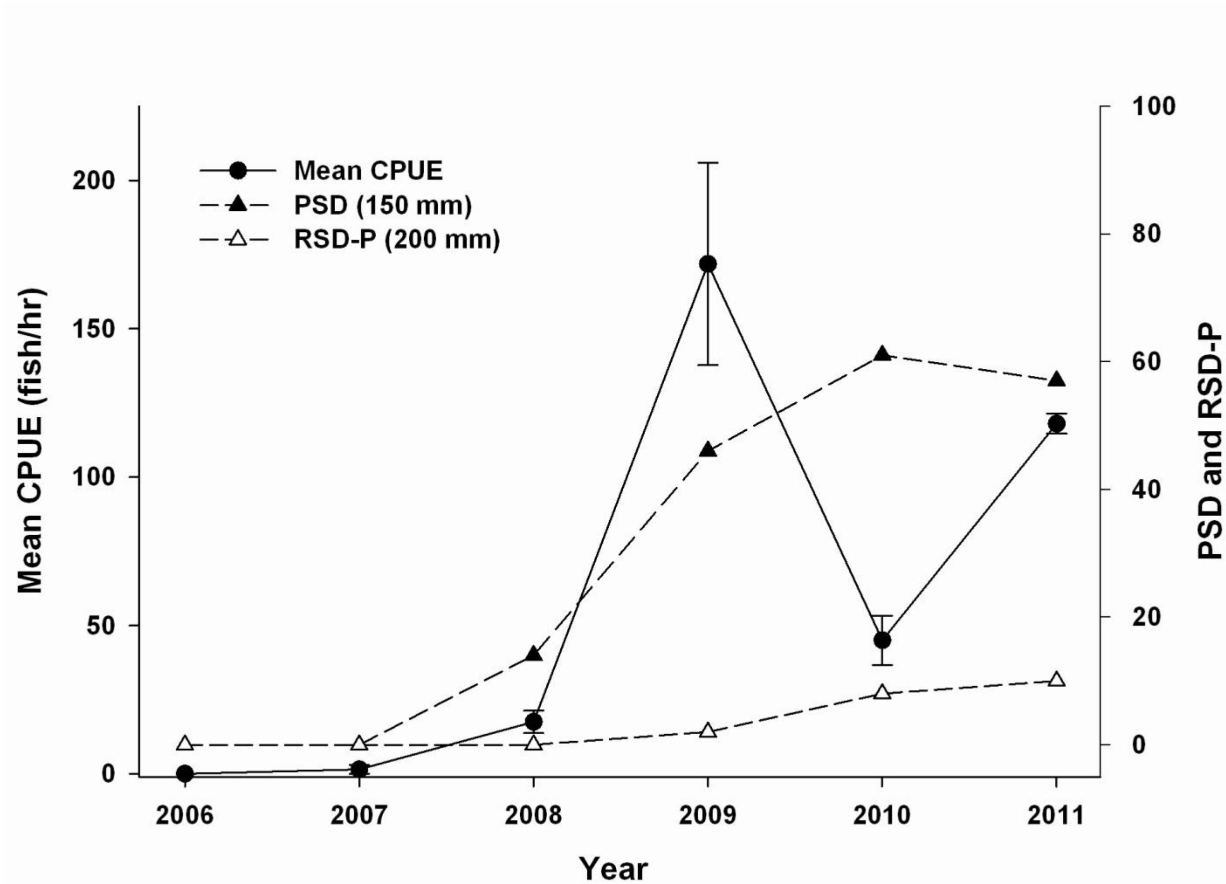


Figure D-5. Annual relative abundance (fish/hr), proportional size distribution (PSD), and relative size distribution (RSD-P) of bluegills captured by electrofishing during the spring in Hackberry Lake from 2006 to 2011. Mean catch per unit effort (CPUE) calculated for bluegill ≥ stock length (80 mm) only.

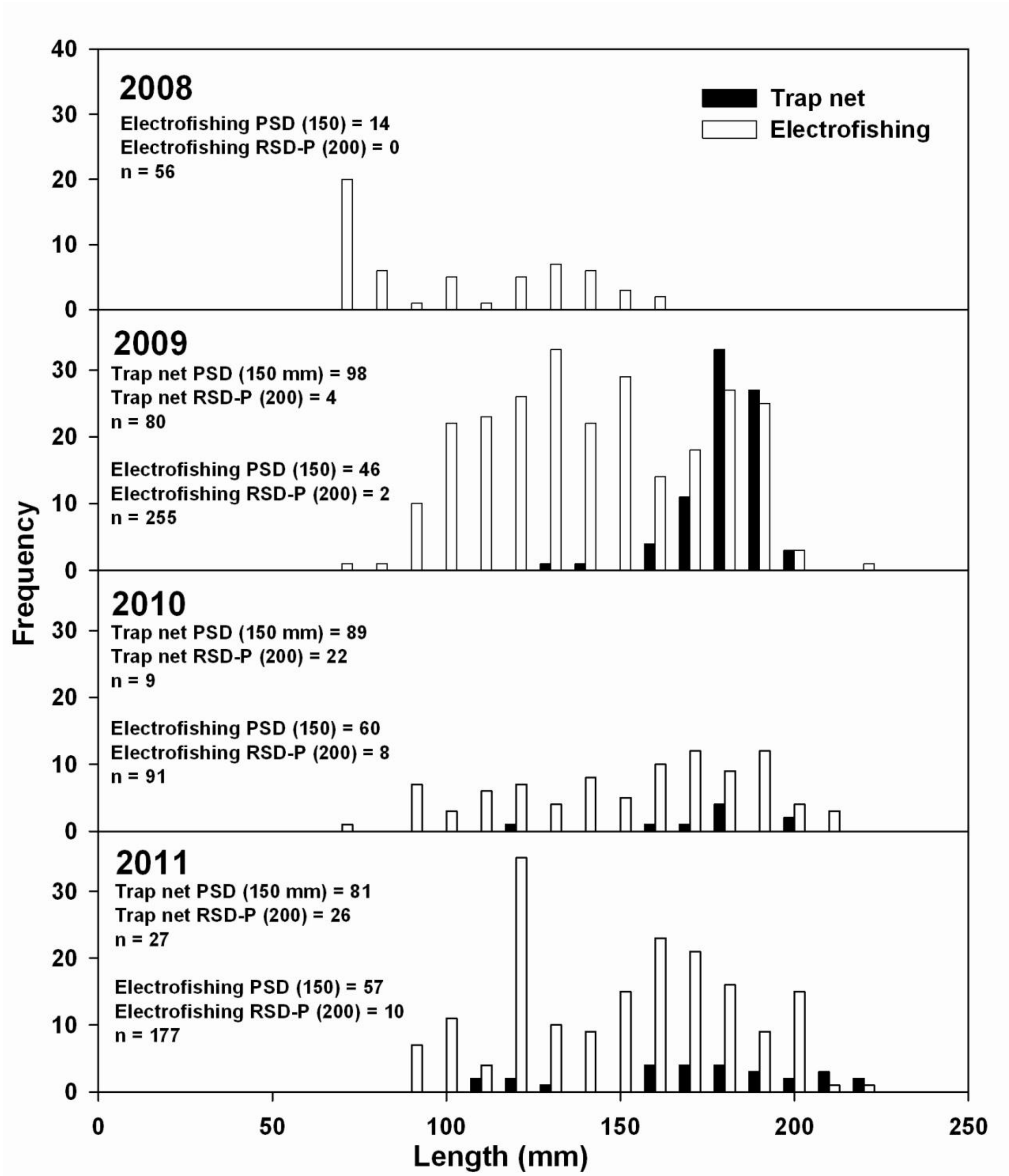


Figure D-6. Length frequency distribution (10-mm length groups) for bluegill in Hackberry Lake captured by trap nets (black bars) in 2009 and 2011 and electrofishing (white bars) from 2008 to 2011.

Table D-2. Bluegill mean relative weight ($W_r$) with standard error (SE) in parenthesis by length category captured by electrofishing and trap nets in Hackberry Lake from 2008 to 2011.

| Year | ≥ Stock<br>Overall $W_r$ | Stock - Quality<br>(80-150 mm)<br>(3-6 in) | Quality - Preferred<br>(150-200 mm)<br>(6-8 in) | Preferred - Memorable<br>(200-250 mm)<br>(8-10 in) | Memorable - Trophy<br>(250-300 mm)<br>(10-12 in) |
|---|---|---|---|---|---|
| 2011 | 122 (1.5) | 116 (2.7) | 126 (2.1) | 124 (3.0) | b |
| 2010 | 115 (2.2) | 110 (4.1) | 117 (3.0) | 120 (2.8) | b |
| 2009 | a | a | a | a | a |
| 2008 | 126 (3.1) | 125 (3.4) | 132 (6.2) | b | b |

a = Sampling did not occur or weights were not recorded during that year.
b = Category had less than two samples for mean and SE calculations, but may have been calculated in overall $W_r$.

## Largemouth bass

The stocking of > 40,000 fingerling largemouth bass in 2007 was successful as the relative abundance of stock length fish substantially increased from 2008 to 2009. Relative abundance in 2011 was similar to 2010 but is trending downwards from the recent high (114 fish/hr) in 2009 (Figure D-7). Electrofishing CPUE (76 fish/net night) was the highest among lakes sampled in 2011. The size structure of the largemouth bass population was similar to 2010 (Figure D-8). Mean relative weight for fish ≥ stock length increased in 2011 compared to 2010; however, overall Wr was the lowest among the Refuge lakes surveyed for the second consecutive year (2010 and 2011; Table D-3).

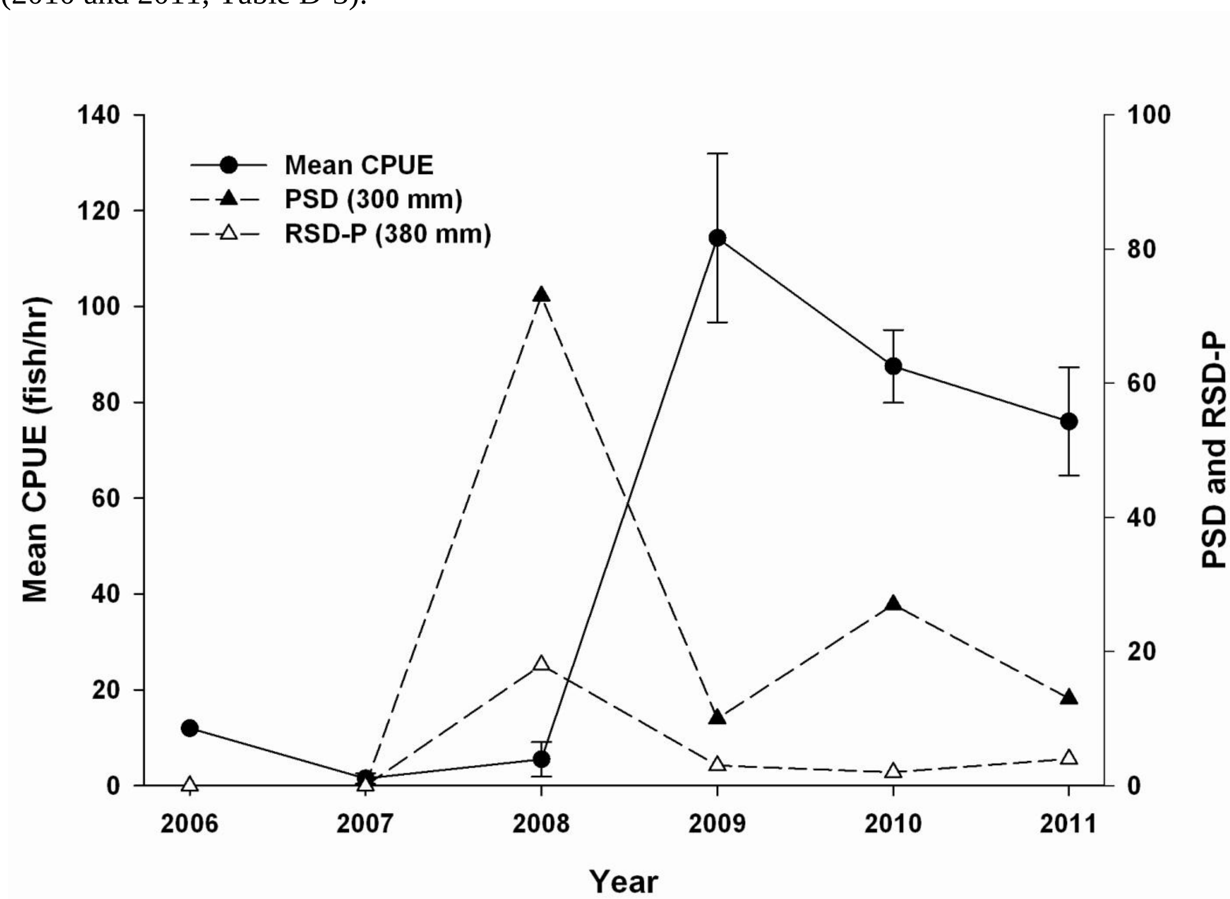


Figure D-7. Annual relative abundance (fish/hr with SE bars), proportional size distribution (PSD), and relative size distribution (RSD-P) of largemouth bass captured by electrofishing during the spring in Hackberry Lake from 2006 to 2011. Mean catch per unit effort (CPUE) calculated for largemouth bass ≥ stock length (200 mm) only.

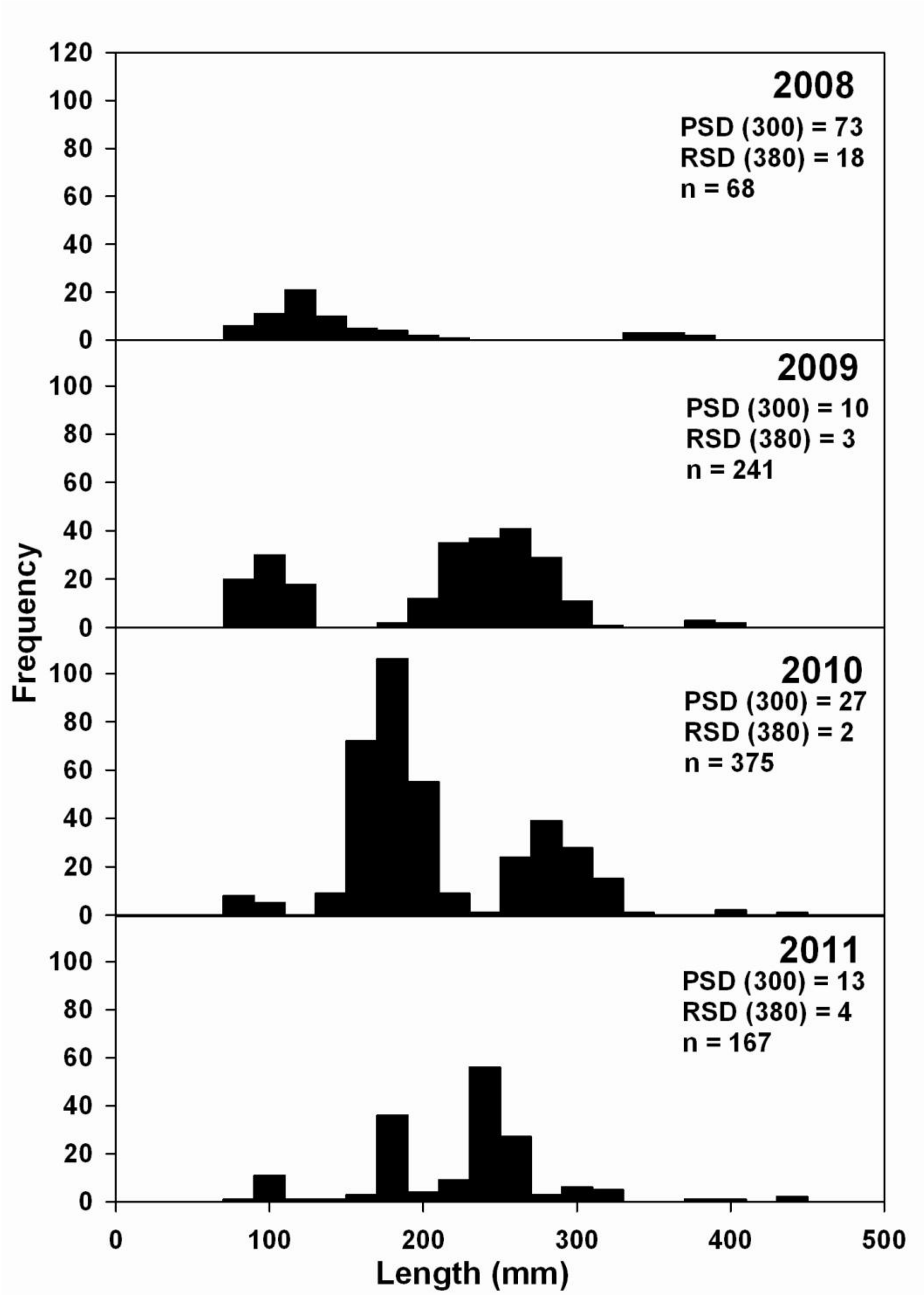


Figure D-8. Length frequency distribution (20-mm length groups) for largemouth bass captured by electrofishing in Hackberry Lake from 2008 to 2011.

Table D-3. Largemouth bass mean relative weight ($W_r$) with standard error (SE) in parenthesis by length category captured by electrofishing in Hackberry Lake from 2008 to 2011.

| Year | ≥ Stock<br>Overall $W_r$ | Stock - Quality<br>(200-300 mm)<br>(8-12 in) | Quality - Preferred<br>(300-380 mm)<br>(12-15 in) | Preferred - Memorable<br>(380-510 mm)<br>(15-20 in) | Memorable - Trophy<br>(510-630 mm)<br>(20-25 in) |
|---|---|---|---|---|---|
| 2011 | 101 (1.5) | 102 (1.4) | 92 (2.4) | 111 (8.5) | b |
| 2010 | 97 (1.2) | 95 (1.2) | 100 (1.5) | 118 (11.1) | b |
| 2009 | 119 (1.4) | 118 (1.6) | 121 (3.5) | 118 (4.0) | b |
| 2008 | 121 (1.6) | 120 (1.5) | 120 (5.6) | 148 (2.0) | b |

a = Sampling did not occur or weights were not recorded during that year.
b = Category had less than two samples for mean and SE calculations, but may have been calculated in overall $W_r$.

**Yellow perch**

Fall gill net mean CPUE has been trending upwards since 2009 (Figure D-9) and was the highest among lakes sampled in 2010 and 2011. Mean $W_r$ for all length categories slightly decreased compared to 2010 (Table D-4), whereas size structure (Figure D-10) remained unchanged from 2009 to 2011. The combination of high relative abundance, a size structure of catchable fish, and yellow perch in good physical condition is likely to lead to excellent angling opportunities in the short-term.

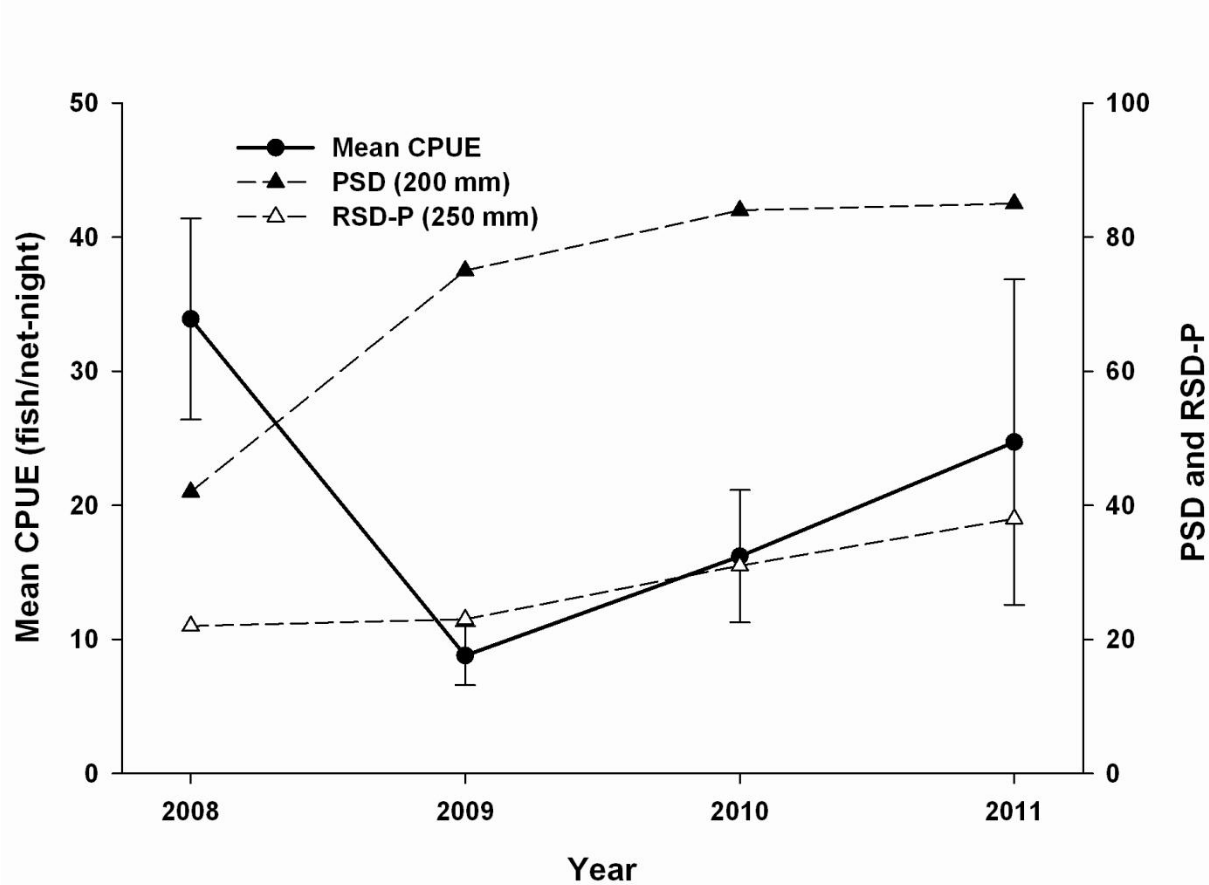


Figure D-9. Annual relative abundance (fish/net-night with SE bars), proportional size distribution (PSD), and relative size distribution (RSD-P) of yellow perch captured by gill nets during fall in Hackberry Lake from 2008 to 2011. Mean catch per unit effort (CPUE) calculated for yellow perch ≥ stock length (130 mm) only.

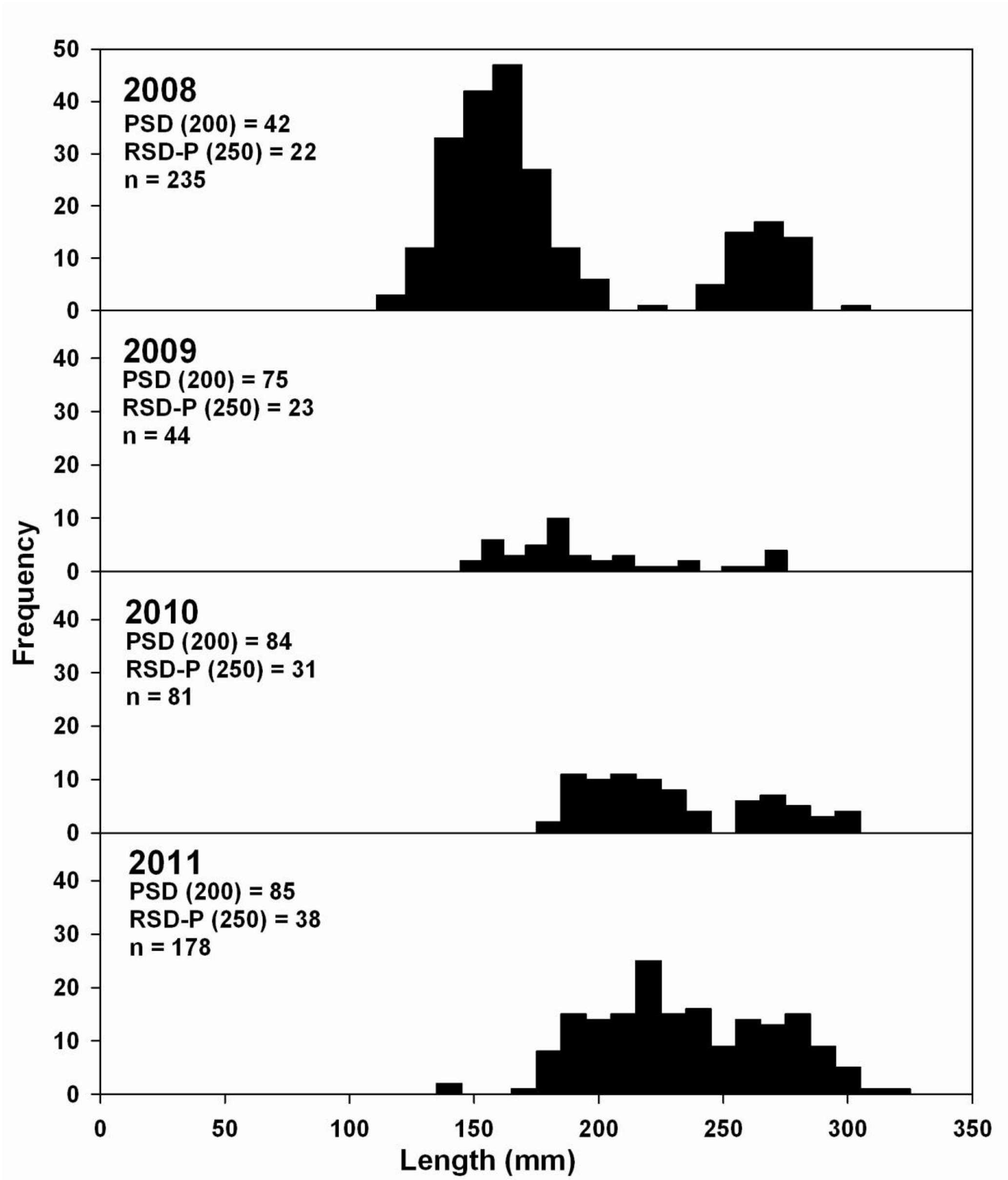


Figure D-10. Length frequency distribution (10-mm length groups) of yellow perch captured by gill netting in Hackberry Lake during the fall from 2008 to 2011.

Table D-4. Yellow perch mean relative weight ($W_r$) with standard error (SE) in parenthesis by length category captured by spring (S) electrofishing or fall (F) gill netting in Hackberry Lake from 2006 to 2011.

| Year | ≥ Stock Overall $W_r$ | Stock - Quality (130-200 mm) (5-8 in) | Quality - Preferred (200-250 mm) (8-10 in) | Preferred - Memorable (250-300 mm) (10-12 in) | Memorable - Trophy (300-380 mm) (12-15 in) |
|---|---|---|---|---|---|
| 2011 (F) | 91 (1.0) | 92 (1.8) | 95 (1.5) | 91 (1.5) | 77 (2.7) |
| 2010 (F) | 96 (1.3) | 98 (4.2) | 96 (1.8) | 96 (2.7) | 94 (2.8) |
| 2009 (F) | 92 (1.3) | 95 (2.5) | 89 (2.0) | 95 (3.1) | 95 (1.8) |
| 2009 (S) | a | a | a | a | a |
| 2008 (F) | 106 (2.0) | 114 (2.4) | 103 (5.6) | 100 (1.4) | b |
| 2008 (S) | 104 (1.2) | 109 (1.6) | 97 (2.3) | 102 (2.3) | b |
| 2007 (S) | 95 (1.0) | 93 (1.2) | 97 (1.7) | 95 (1.7) | b |
| 2006 (S) | 108 (3.4) | 107 (3.7) | 115 (8.1) | b | b |

a = Sampling did not occur or weights were not recorded during that year.
b = Category had less than two samples for mean and SE calculations, but may have been calculated in overall $W_r$.

## Summary

Common carp – All common carp appear to be from the same 2006 year class. These carp are likely to reproduce within the next few years, so age-1 and young-of-the-year should be expected in the short-term.

Northern pike – The population remains at a low abundance but has trended upwards for the last two years. One fish < stock length was captured indicating that natural reproduction may be occurring or illegal stockings continue.

Bluegill – Relative abundance increased from 2010 while size structure improved, providing excellent angling opportunities for larger sized fish.

Largemouth bass – Size structure continued to improve in Hackberry Lake while relative weights increased for smaller fish and declined for larger fish.

Yellow perch – Yellow Perch CPUE continued to trend upwards for the second consecutive year. Excellent angling opportunities exist for yellow perch in Hackberry Lake.

## Management Recommendations

1. Since the introduction of common carp and northern pike, continue annual surveys of electrofishing, trap netting, and gill netting.

2. Continue to improve boat ramps including handicap accessibility.

3. Identify how common carp and northern pike entered Hackberry Lake.

4. Discuss plans to remove common carp in Hackberry Lake including complete renovation once game fish populations begin to decline.

5. Add signs near lake access points to inform anglers of the illegal activity of moving fish from one lake to another.

# PELICAN LAKE

## Lake Description

Pelican Lake is located three miles south of Highway 16B just west of Valentine NWR headquarters then two miles east along the Pelican Lake sub-headquarters road. The roads are black topped most of the way to the lake, and the west boat ramp is usually accessible. The lake receives heavy angling pressure during the spring and again during the winter ice-fishing season. Pelican Lake has been known as the best fishery on the Refuge and is noted for producing trophy bluegill. The excellent fishery is related to the lake depth, the ratio of open water to submergent vegetation during summer, and the abundance of emergent vegetation.

Pelican Lake is 331 surface ha (817 acres). Maximum depth is 3.3 m (10 ft) with a mean depth of 1.3 m (4 ft). Specific conductivity averages 328 μS/cm, total alkalinity averages 160 mg/L, phenolphthalein alkalinity averages 10 mg/L, pH ranges from 8 during winter through spring to 9 during summer and secchi disc readings average 0.3 m. The lake does not develop a thermocline and is a closed system except during periods of excessive rainfall when sheet flow occurs. The lake is situated in the lowlands of the surrounding sandhills, and these conditions create many springs within the lake. The springs provide summer thermal refuge for cool-water species (e.g., northern pike) and are important because surface water temperatures can exceed 30 °C. The bottom is relatively flat with high organic content. These conditions coupled with the shallow depth make the lake susceptible to winter kills when the ice remains snow covered for extended periods. However, the presence of springs likely reduces the occurrence and severity of winter-kills. Emergent vegetation is primarily cattail, bulrush, and *Phragmites*, but scattered stands of wild rice (*Zizania spp.*) occur. Submergent vegetation includes milfoil (*Myriophyllum spp.)*, curly-leaf pondweed (*Potamogeton spp.)*, and scattered areas of coontail (*Ceratophyllum spp.*). The surrounding watershed is rolling sandhills with mixed grasses interspersed with a few cottonwoods and willows along the shoreline. The fishery includes yellow perch, northern pike, largemouth bass, bluegill, black bullhead, and common carp.

Pelican Lake has a similar history of common carp infestation as the other refuge lakes but to a lesser degree. Pelican Lake was chemically renovated during 1979, but a complete kill did not occur as common carp were captured in 1980 surveys. A limited winter-kill was noted during 1987 – 88. The spring and summer of 1995 – 1997 were years with excessive run-off and high water. Many of the refuge lakes, including Pelican, were full and overflowing. The high water resulted in many of the lakes becoming inter-connected and fish movement was observed.

Northern pike size restrictions changed four times from 1987 to 1993 (Appendix B) to improve the size structure and abundance of this species to biologically control common carp populations. Northern pike greater than 28 in have been protected since 1993. The common carp population in Pelican Lake appears to have stabilized since an increase was observed in 2003. It appears that common carp successfully spawn nearly every year and there is some recruitment. Northern pike are likely having an affect on the common carp population; however, current low northern pike numbers may allow a strong common carp year class to establish.

Water quality parameters collected were water temperature, dissolved oxygen, pH, salinity, alkalinity, and conductivity (Table E-1). Additionally, water chemistry analysis was performed to determine nitrite, nitrate, total nitrogen, ammonia, ortho-phosphorous, and total phosphorous levels for Pelican Lake (Appendix I).

Table E-1. Pelican Lake surface water quality parameters from 1999 to 2011.

| Date | Time | Water temp. (°C) | D.O. (mg/L) | Secchi depth (cm) | pH | Salinity (ppt) | Phenolphthalein alkalinity (mg/L) | Total alkalinity (mg/L) | Conductivity (µS/cm) |
|---|---|---|---|---|---|---|---|---|---|
| 08/2010 | 1750 | 23 | 13.3 | 48 | 9.6 | | 17 | 171 | 275 |
| 06/2011 | | 18 | 6.0 | | 8.7 | | 0 | 129 | 320 |
| 05/2010 | 2340 | 17 | 6.2 | | 8.2 | | 0 | 171 | 315 |
| 08/2009 | 0930 | 20 | 8.4 | | 8.9 | | 0 | 120 | 317 |
| 05/2009 | 1820 | 23 | 8.5 | 40 | 8.5 | | 0 | 153 | 369 |
| 09/2008 | | 20 | 15.4 | | 9.4 | 0.2 | 34 | 120 | 308 |
| 05/2008 | | 16 | 11.3 | | | 0.2 | 0 | 171 | 298 |
| 05/2007 | | 20 | 7.4 | | 6.8 | 0.2 | 17 | 137 | 351 |
| 06/2006 | | 24 | 8.1 | 129 | 6.9 | 0.2 | 0 | 137 | 378 |
| 08/2005 | | 21 | | | 8.5 | | | 240 | 320 |
| 09/2004 | | 23 | | 30 | | | 0 | 205 | 375 |
| 09/2003 | | 23 | | | | | | | |
| 09/2001 | | 18 | | 36 | 7.5 | | 8 | 120 | 318 |
| 07/2001 | 2000 | 28 | 11.7 | | 7.7 | | 25 | 110 | |
| 07/2001 | 0845 | 24 | 7.0 | | 8.7 | | 17 | 127 | |
| 09/2000 | | 18 | | 30 | 8.0 | | 0 | 205 | |
| 09/1999 | | 14 | | | 10.0 | | | | |

# Results and Discussion

## Common carp

Gill net mean CPUE substantially decreased from 2007 to 2009 where it has been trending upwards for the last two years (Figure E-1). Trap net mean CPUE appears to be at pre 2009 levels following dramatic swings in relative abundance estimates in 2009 and 2010 (Figure E-2). Trap net mean CPUE was the lowest among lakes sampled in 2011. Overall, relative abundance estimates are showing a slight increase in the number of common carp stock length and greater in Pelican Lake compared to 2010. Five large, adult common carp in the memorable length category were captured in 2011 (Figure E-3).

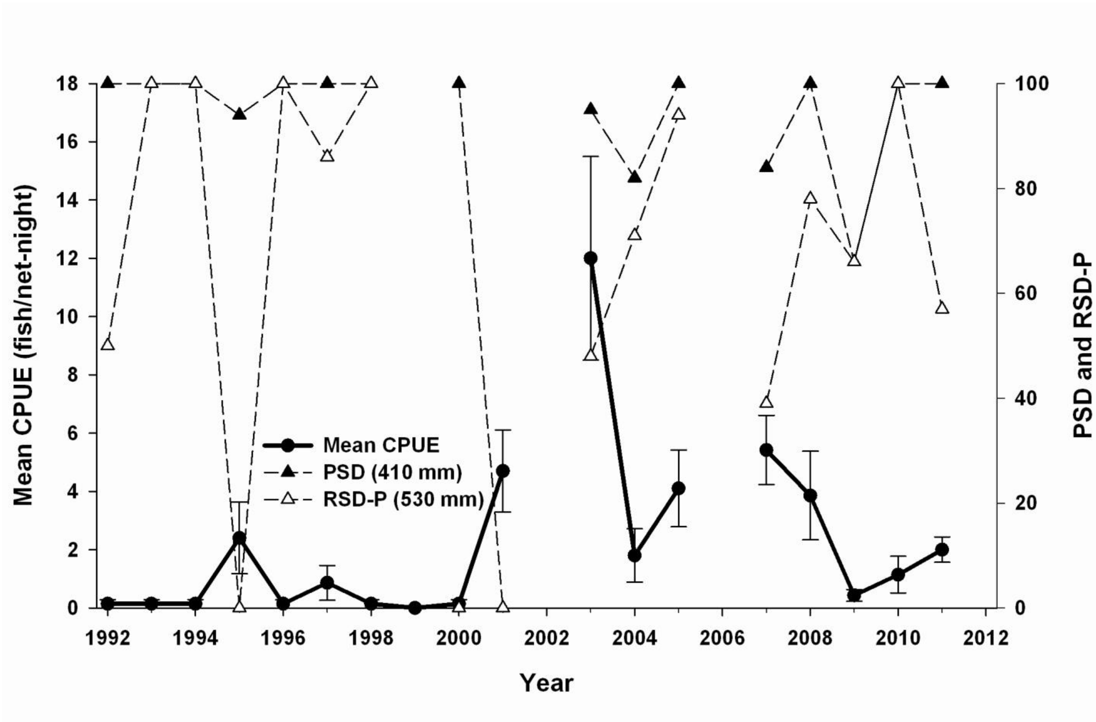


Figure E-1. Annual relative abundance (fish/net-night with SE bars), proportional size distribution (PSD), and relative size distribution (RSD-P) of common carp captured by gill nets during the fall in Pelican Lake from 1992 to 2011. Mean catch per unit effort (CPUE) calculated for carp ≥ stock length (280 mm) only.

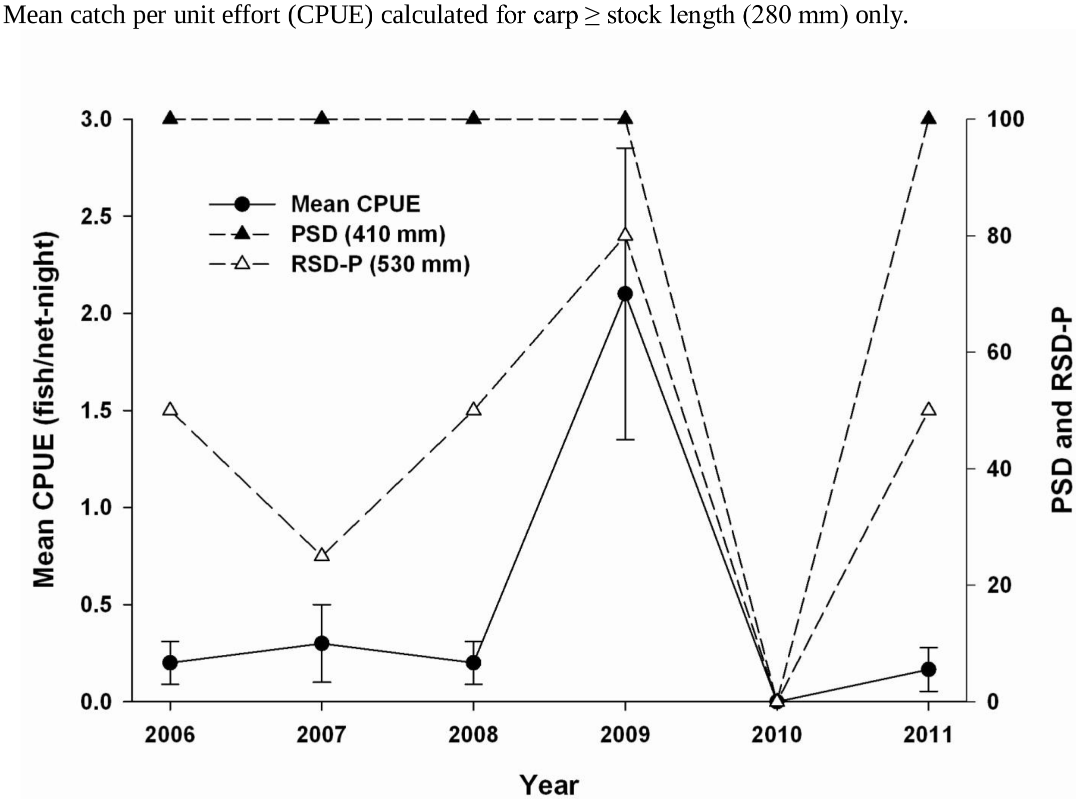


Figure E-2. Annual relative abundance (fish/net-night with SE bars), proportional size distribution (PSD), and relative size distribution (RSD-P) of common carp captured by trap nets during the spring in Pelican Lake from 2006-2011. Mean catch per unit effort (CPUE) calculated for common carp ≥ stock length (280 mm) only.

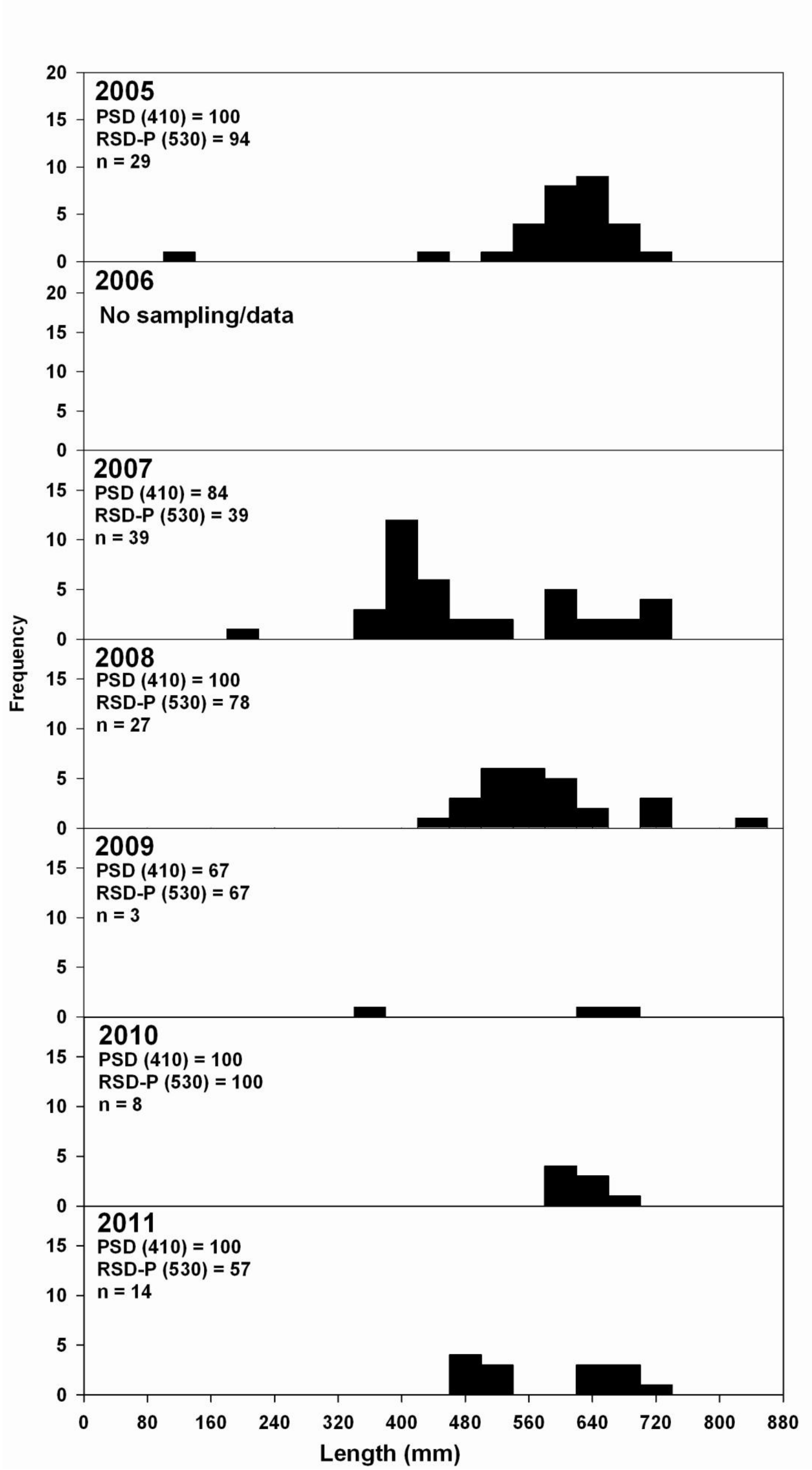


Figure E-3. Length frequency distribution (40-mm length groups) of carp captured in gill nets during the fall in Pelican Lake from 2005 to 2011. Gill nets were not deployed in 2006 due to inaccessibility during low water.

**Northern Pike**

During the past three years, the total number of northern pike captured, PSD, and RSD-P have remained nearly unchanged in Pelican Lake (Figure E-4). Trap net relative abundance estimates have remained fairly constant from 2006 – 2011 with the exception of 2010 (Figure E-5) and gill net CPUE estimates have also remained constant since 2007 (Figure E-6). For the second consecutive year since 2005, Pelican Lake has produced large (memorable length; ≥ 860 mm) northern pike (Figure E-7), while both Clear and Dewey lakes consistently produce large northern pike. Relative weights of northern pike in Pelican Lake were similar to Dewey and Clear lakes for all length categories (Table E-2).

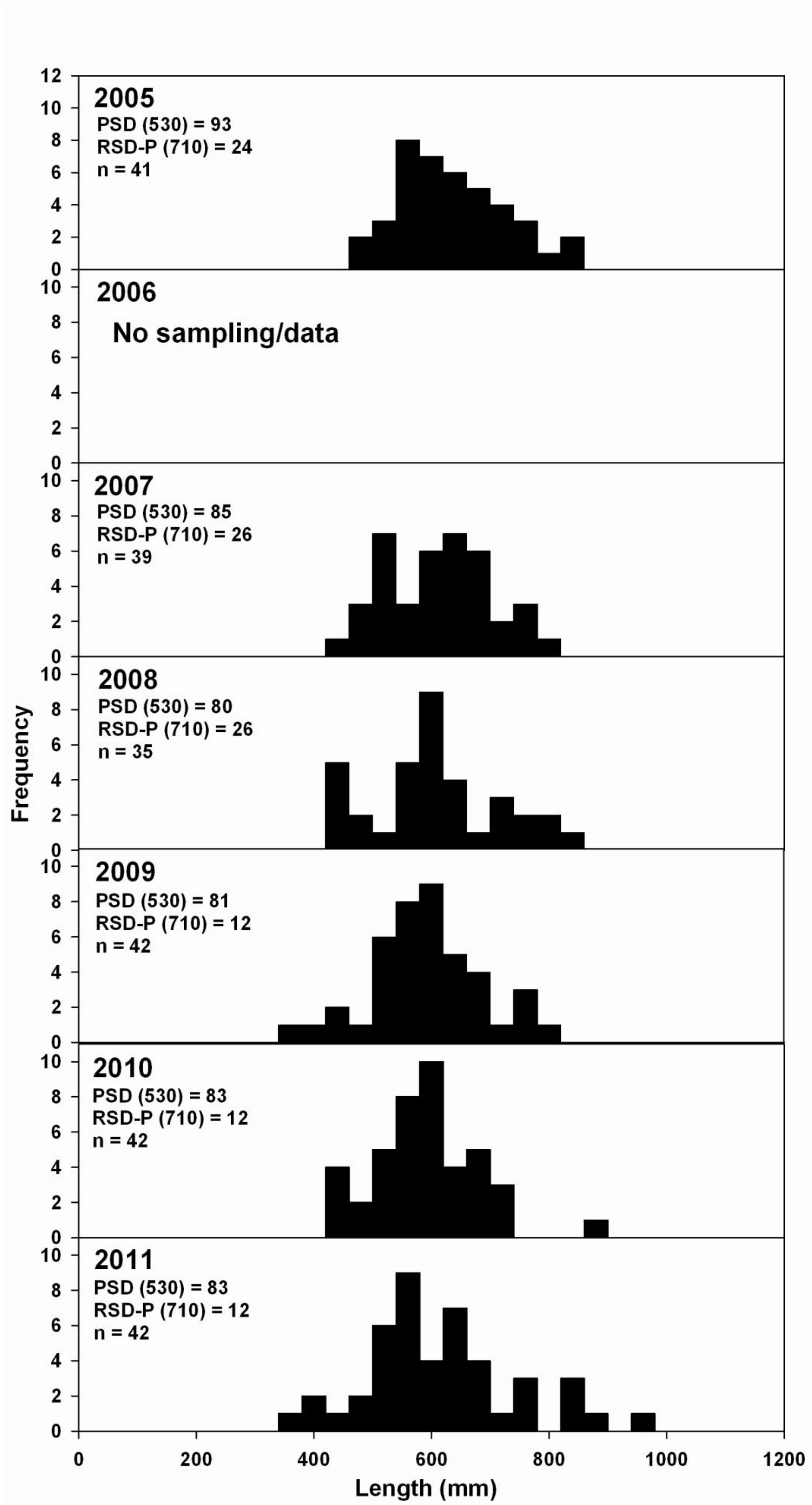


Figure E-4. Length frequency distribution (40-mm length groups) for northern pike captured with gill nets during the fall in Pelican Lake from 2005 to 2011. Gill nets were not deployed in 2006 due to inaccessibility during low water.

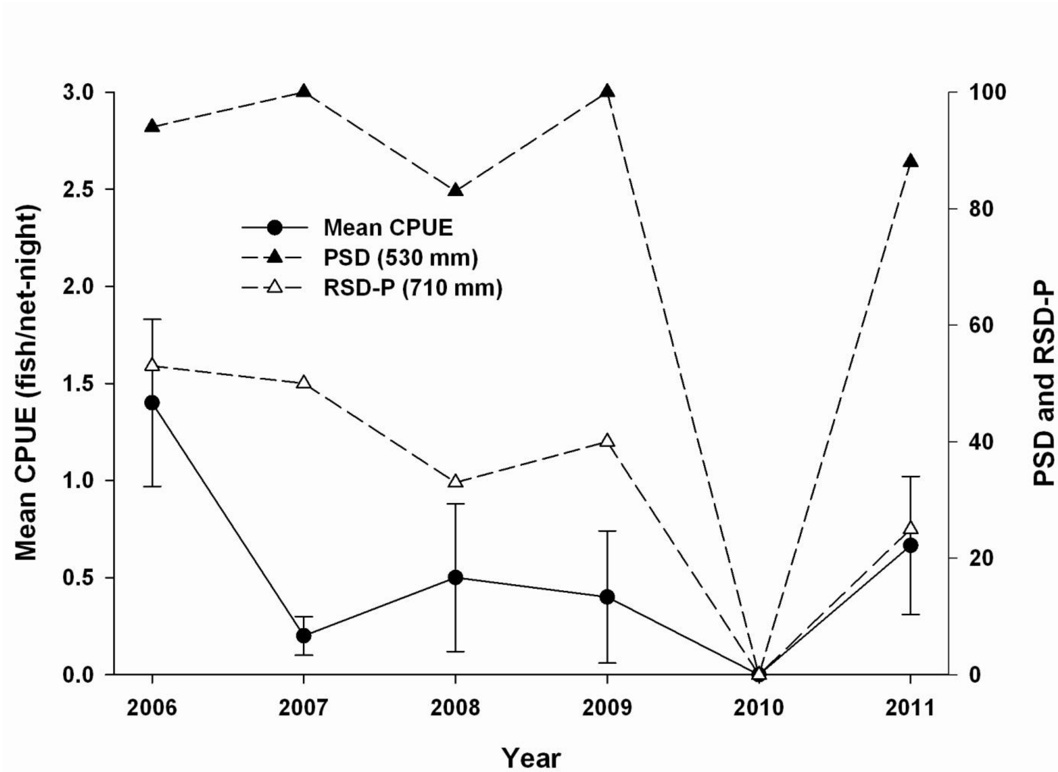


Figure E-5. Annual relative abundance (fish/net-night with SE bars), proportional size distribution (PSD), and relative size distribution (RSD-P) of northern pike captured by trap nets during the spring in Pelican Lake from 2006 to 2011. Mean catch per unit effort (CPUE) calculated for northern pike ≥ stock length (350 mm) only.

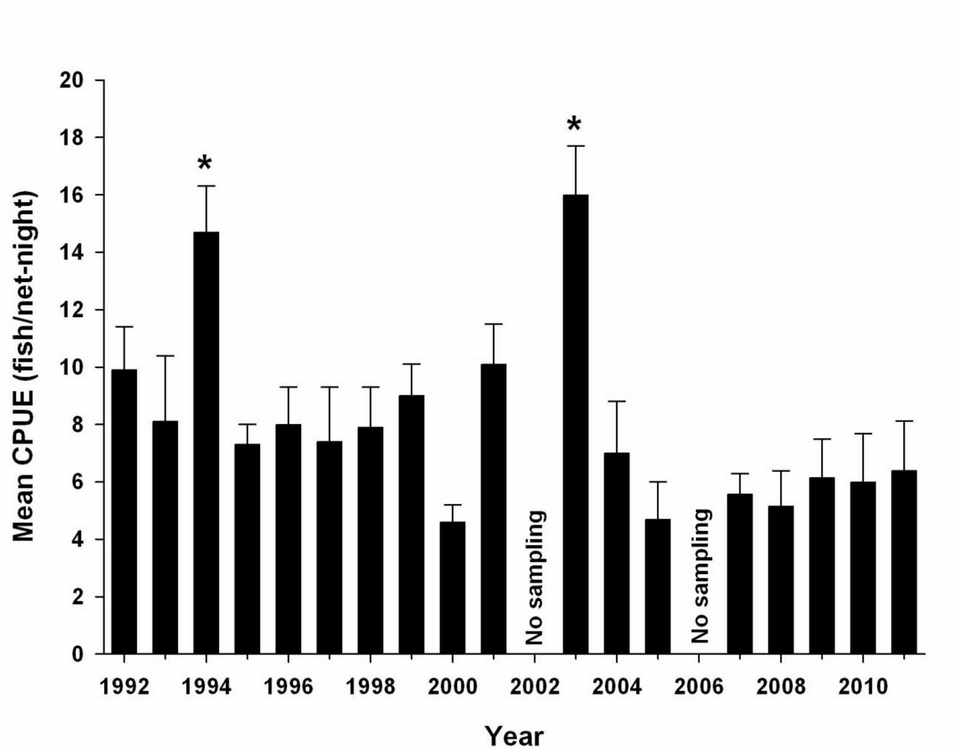


Figure E-6. Northern pike gill net mean catch per unit effort (CPUE) in Pelican Lake from 1992 to 2011. Years with an asterisk were significantly different ($P < 0.20$) from 2011 using ANOVA with Tukey-Kramer multiple comparison tests.

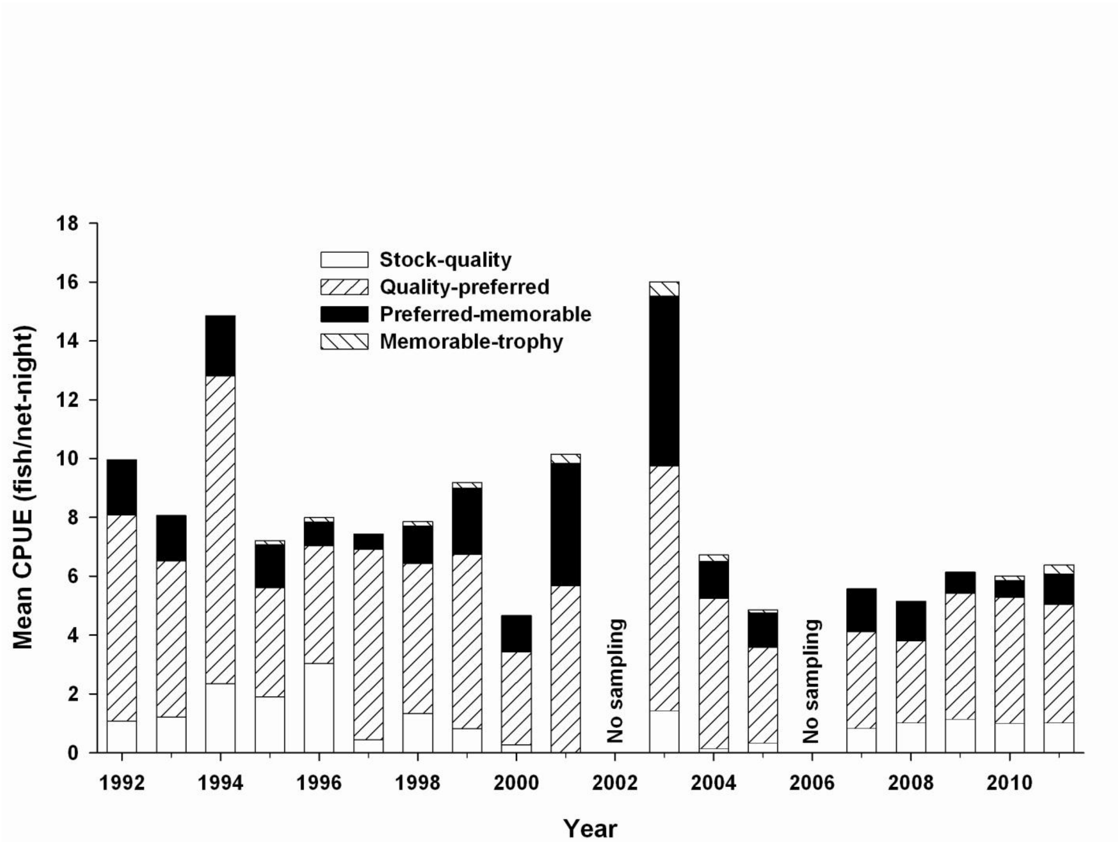


Figure E-7. Gill-net mean catch per unit effort (CPUE) for northern pike by length category in Pelican Lake from 1992 to 2011.

Table E-2. Northern pike population size structure, traditional proportional size distribution (PSD), and incremental relative size distribution (RSD) with mean relative weights ($W_r$) in Pelican Lake during the fall from 1989 to 2011. Data are pooled for trap nets and gill nets from 1989 to 2005. Data from 2006 to 2011 are for fall gill nets only. Data are summarized by length categories with 80% confidence intervals (+/-; Gustafson 1988).

| Year | % ≥ Quality | | Stock - Quality (350-530mm) (14-21 in) | | | Quality to Preferred (530-710mm) (21-28 in) | | | Preferred to memorable (710-860mm) (28-34 in) | | | Memorable to trophy (860-1120mm) (34-44 in) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PSD | $W_r$ | RSD | ± | $W_r$ | RSD | ± | $W_r$ | RSD | ± | $W_r$ | RSD | ± | $W_r$ |
| 2011 | 84 | 88 | 16 | 9 | 101 | 63 | 11 | 90 | 16 | a | 86 | 5 | a | 83 |
| 2010 | 83 | 93 | 17 | 9 | 103 | 71 | 11 | 91 | 10 | a | 87 | 2 | a | 92 |
| 2009 | 81 | 92 | 19 | 9 | 94 | 70 | 10 | 93 | 12 | a | 84 | 0 | a | |
| 2008 | 80 | 93 | 20 | 11 | 96 | 54 | 13 | 96 | 26 | 12 | 87 | 0 | a | |
| 2007 | 85 | 109 | 15 | a | 113 | 59 | 18 | 113 | 26 | a | 98 | 0 | a | |
| 2006 | No fall gill net sampling in 2006 due to low water levels | | | | | | | | | | | | | |
| 2005 | 93 | 90 | 7 | a | 108 | 69 | 15 | 94 | 25 | a | 74 | 2 | a | 75 |
| 2004 | 93 | 105 | 2 | a | 110 | 73 | 11 | 94 | 18 | a | 72 | 3 | a | 88 |
| 2003 | 91 | 89 | 9 | 14 | 97 | 52 | 10 | 93 | 36 | 12 | 81 | 3 | a | 84 |
| 2002 | No fall trap or gill netting conducted in 2002 due to low water levels | | | | | | | | | | | | | |
| 2001 | 100 | 93 | 0 | a | 0 | 56 | 9 | 95 | 41 | 9 | 87 | 3 | a | 94 |
| 2000 | 94 | 88 | 6 | a | 82 | 69 | 2 | 89 | 27 | 3 | 86 | | | |
| 1999 | 91 | 88 | 9 | 6 | 94 | 66 | 9 | 87 | 25 | 8 | 88 | 2 | a | 86 |
| 1998 | 83 | 89 | 17 | 7 | 90 | 65 | 9 | 89 | 16 | 7 | 87 | 2 | a | 91 |
| 1997 | 94 | 98 | 6 | 5 | 106 | 87 | 7 | 99 | 7 | 6 | 88 | | | |
| 1996 | 62 | 93 | 38 | 8 | 96 | 50 | 12 | 92 | 10 | 7 | 88 | 2 | 8 | 96 |
| 1995 | 74 | 90 | 26 | 9 | 92 | 51 | 12 | 88 | 20 | 11 | 90 | 2 | 9 | 109 |
| 1994 | 84 | 106 | 16 | 5 | 110 | 71 | 6 | 110 | 14 | 5 | 100 | 0 | | |
| 1993 | 85 | 90 | 15 | 6 | 90 | 65 | 9 | 97 | 19 | 6 | 93 | 0 | | |
| 1992 | 89 | 68 | 11 | | 45 | 71 | | 72 | 19 | | 58 | 0 | | |
| 1991 | 94 | 86 | 6 | 5 | 100 | 81 | 7 | 84 | 13 | 6 | 89 | 0 | | |
| 1990 | 96 | 91 | 4 | 6 | 95 | 83 | 9 | 92 | 11 | 6 | 91 | 2 | | 89 |
| 1989 | 86 | 98 | 14 | | 101 | 72 | | 93 | 8 | | 101 | 6 | | 102 |

a = Confidence intervals could not be calculated due to small sample size.

## **Bluegill**

Relative abundance of bluegills increased 603% based on electrofishing (Figure E-8) and 1,725% in trap net (Figure E-9) surveys in 2011, compared to 2010. The length range of bluegills captured in Pelican Lake while electrofishing and trap netting in 2011 was similar between gears, while electrofishing caught four times the number of fish (Figure E-10). Mean $W_r$ for all length categories increased with largest increases in condition found for the largest length groups (Table E-3).

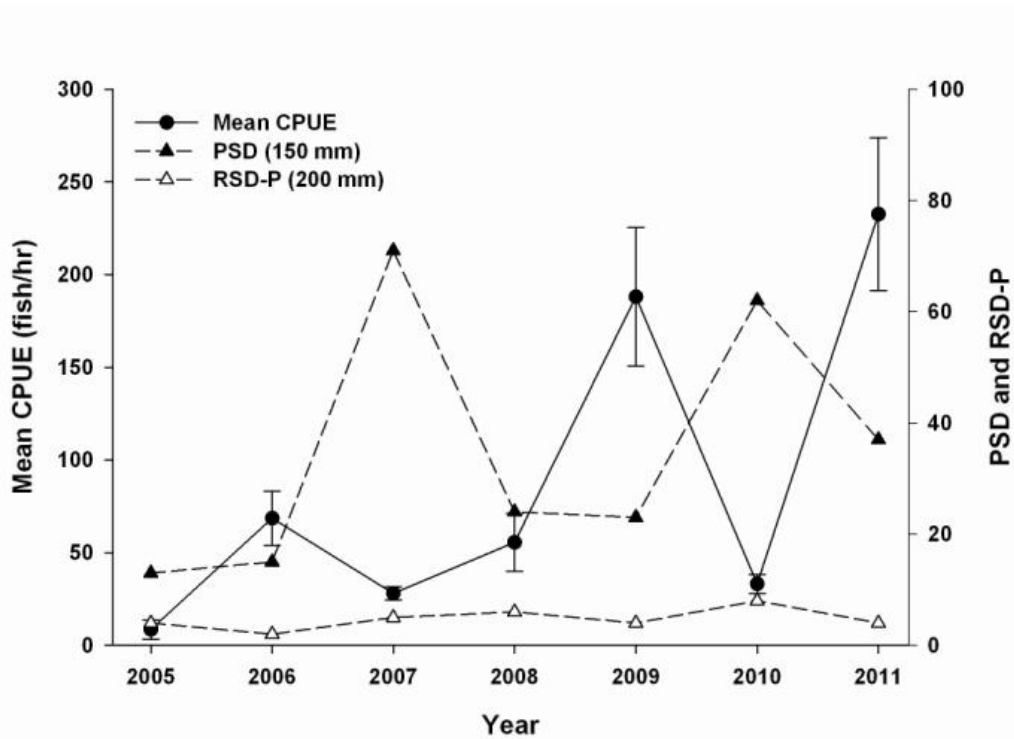


Figure E-8. Annual relative abundance (fish/hr with SE bars), proportional size distribution (PSD), and relative size distribution (RSD-P) of bluegills captured by electrofishing in Pelican Lake from 2005 to 2011. Mean catch per unit effort (CPUE) calculated for bluegill ≥ stock length (80 mm) only.

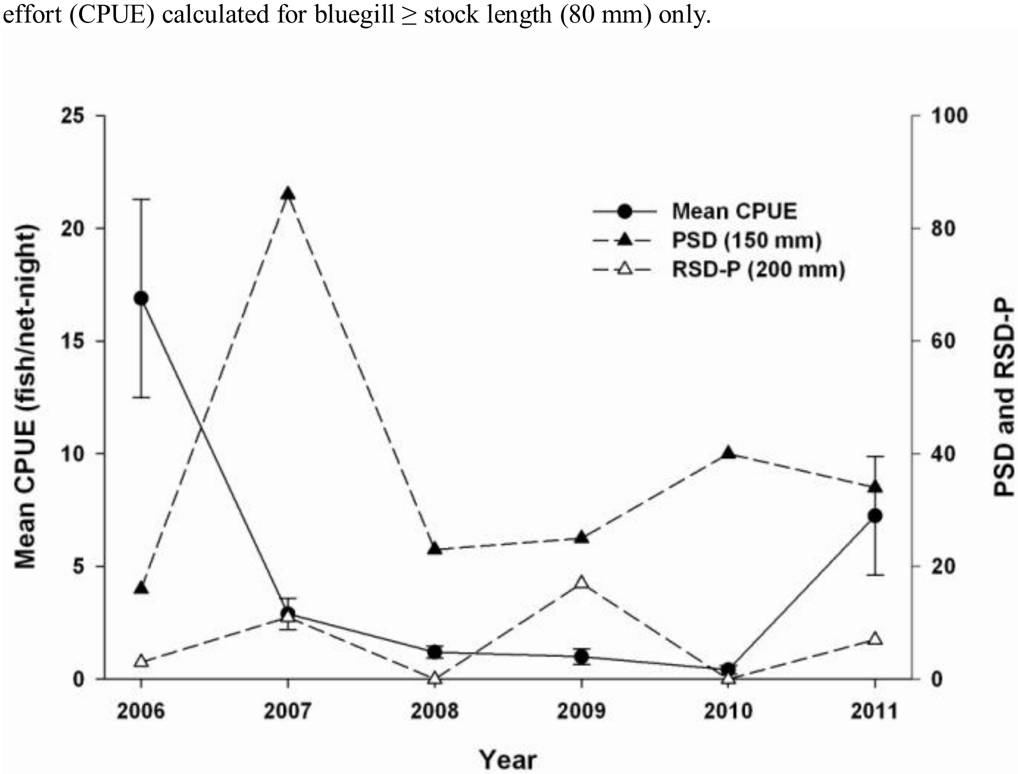


Figure E-9. Annual relative abundance (fish/net-night), proportional size distribution (PSD), and relative size distribution (RSD-P) of bluegills captured by trap nets during the spring in Pelican Lake from 2006 to 2011. Mean catch per unit effort (CPUE) calculated for bluegill ≥ stock length (80 mm) only.

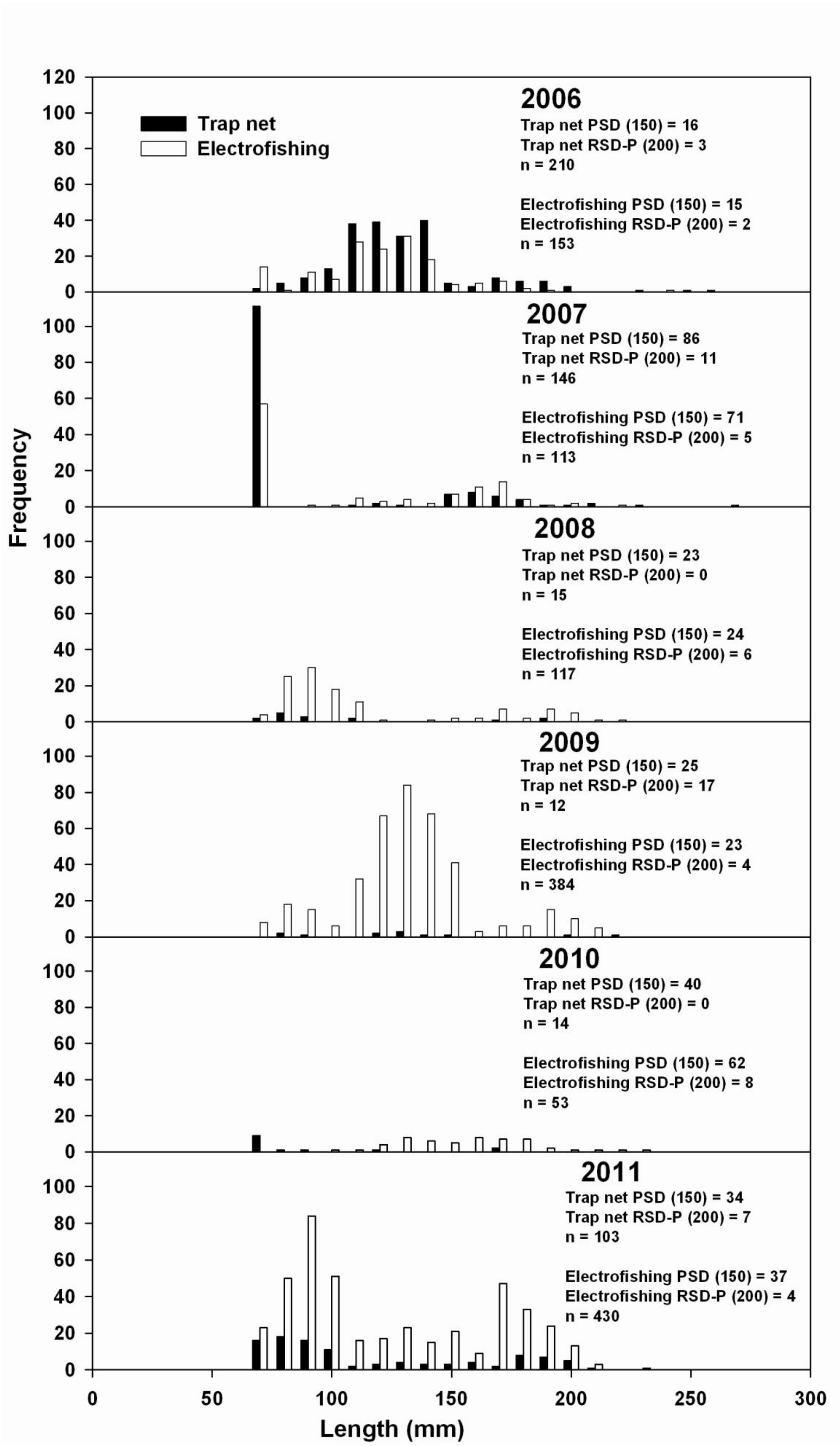


Figure E-10. Length frequency distribution (10-mm length groups) for bluegills captured by trap nets (black bars) and electrofishing (white bars) during the spring in Pelican Lake from 2006 to 2011.

Table E-3. Bluegill mean relative weight ($W_r$) with standard error (SE) in parenthesis by length category captured by electrofishing and trap nets in Pelican Lake from 1992 to 2011. Sampling occurred during fall from 1992 to 2004 and during the spring from 2005 to 2011.

| Year | ≥ Stock Overall $W_r$ | Stock - Quality (80-150 mm) (3-6 in) | Quality - Preferred (150-200 mm) (6-8 in) | Preferred - Memorable (200-250 mm) (8-10 in) | Memorable - Trophy (250-300 mm) (10-12 in) |
|---|---|---|---|---|---|
| 2011 | 113 (1.6) | 107 (2.2) | 120 (2.5) | 118 (2.6) | b |
| 2010 | 100 (2.2) | 97 (3.1) | 103 (3.1) | 91 (10.0) | b |
| 2009 | a | a | a | a | a |
| 2008 | 106 (1.4) | 102 (1.8) | 113 (2.1) | 107 (3.8) | b |
| 2007 | 115 (1.5) | 113 (2.0) | 115 (2.0) | 116 (4.6) | b |
| 2006 | 111 (1.3) | 111 (2.0) | 113 (1.4) | 113 (5.5) | 113 (3.8) |
| 2005 | 115 (1.4) | 114 (1.7) | 113 (3.5) | 126 (2.3) | b |
| 2004 | 114 (2.3) | 109 (2.7) | 125 (2.8) | 121 (0.1) | b |
| 2003 | 111 (1.6) | 112 (2.4) | 111 (3.0) | 108 (3.4) | b |
| 2002 | a | a | a | a | a |
| 2001 | 114 (1.9) | 105 (2.2) | 120 (4.0) | 124 (2.4) | b |
| 2000 | 113 (1.8) | 108 (2.9) | 115 (2.2) | 123 (2.6) | 105 (15.6) |
| 1999 | 121 (1.4) | 115 (3.3) | 124 (1.2) | 123 (3.7) | b |
| 1998 | 105 (1.4) | 100 (2.1) | 108 (2.0) | 116 (2.7) | 109 (2.6) |
| 1997 | 109 (1.3) | 102 (1.6) | 109 (2.0) | 120 (2.2) | 120 (2.4) |
| 1996 | 118 (1.5) | 114 (1.6) | 121 (3.4) | 126 (4.0) | 125 (3.7) |
| 1995 | 124 (2.0) | 113 (1.6) | 121 (1.7) | 136 (1.6) | 142 (3.8) |
| 1994 | b | b | b | b | b |
| 1993 | 119 (3.2) | 100 (6.6) | 116 (3.9) | 132 (3.9) | 135 (9.7) |
| 1992 | 122 (1.8) | 113 (2.3) | 129 (3.4) | 125 (2.3) | b |

a = Sampling did not occur or weights were not recorded during that year.
b = Category had less than two samples for mean and SE calculations, but may have been calculated in overall $W_r$.

## Golden shiner

No golden shiners were captured during the 2011 sampling season, while in 2010 four golden shiners were captured with six caught in 2009, and two caught in 2008.

## Largemouth bass

During 2011 mean CPUE of largemouth bass increased 46% from 2010 levels yet remained lower than 2008 and 2009 (Figure E-11). Mean relative abundance of largemouth bass in Pelican Lake was the lowest of all lakes sampled in 2011. A strong year class likely produced in 2005 continues to transition through the population (Figure E-12). Due to limited recruitment since 2006, the size structure has moved out of balance with 55% of the fish ≥ preferred length. Mean $W_r$ for fish ≥ stock length was the highest among the refuge lakes sampled each year (Clear, Dewey, Hackberry, and Pelican; Table E-4).

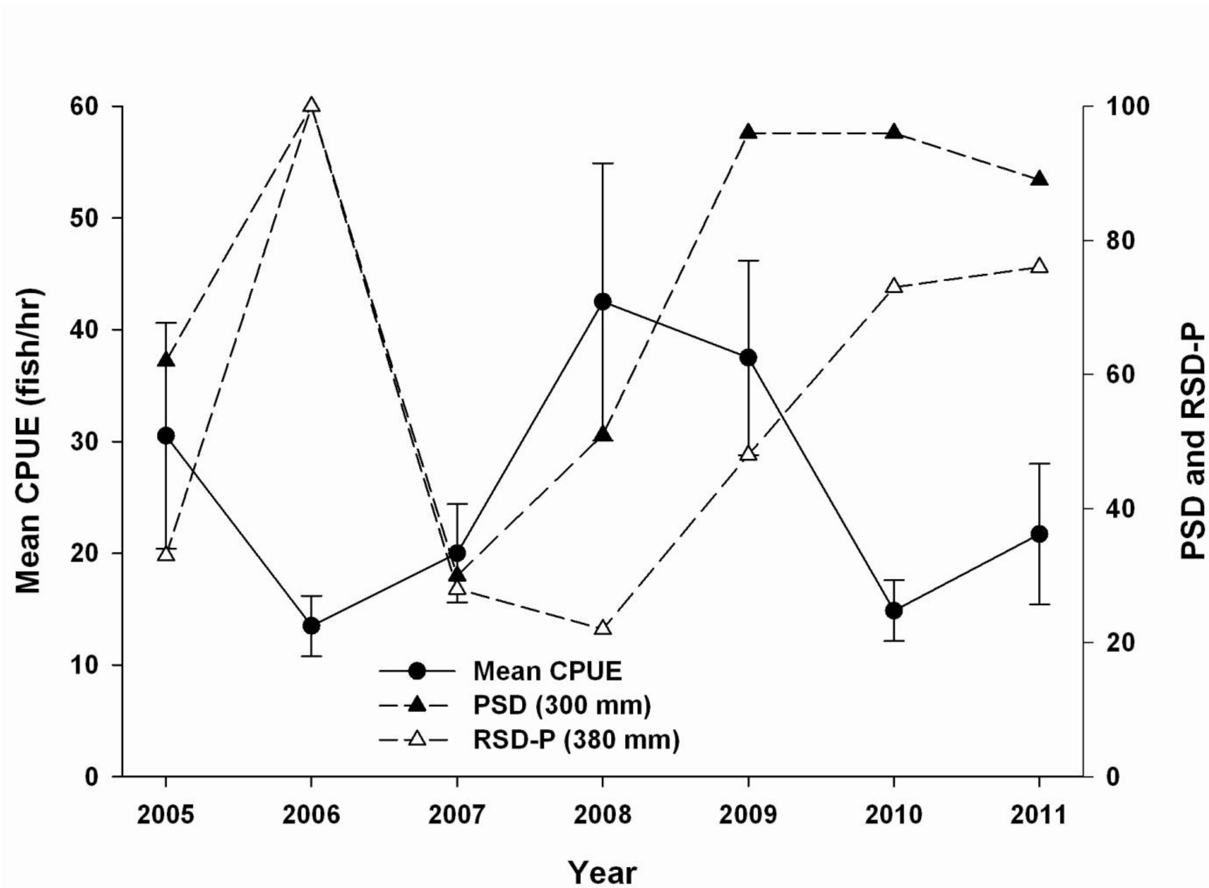


Figure E-11. Annual relative abundance (fish/hr with SE bars), proportional size distribution (PSD), and relative size distribution (RSD-P) of largemouth bass captured by spring time electrofishing in Pelican Lake from 2005 to 2011. Mean catch per unit effort (CPUE) calculated for largemouth bass ≥ stock length (200 mm) only.

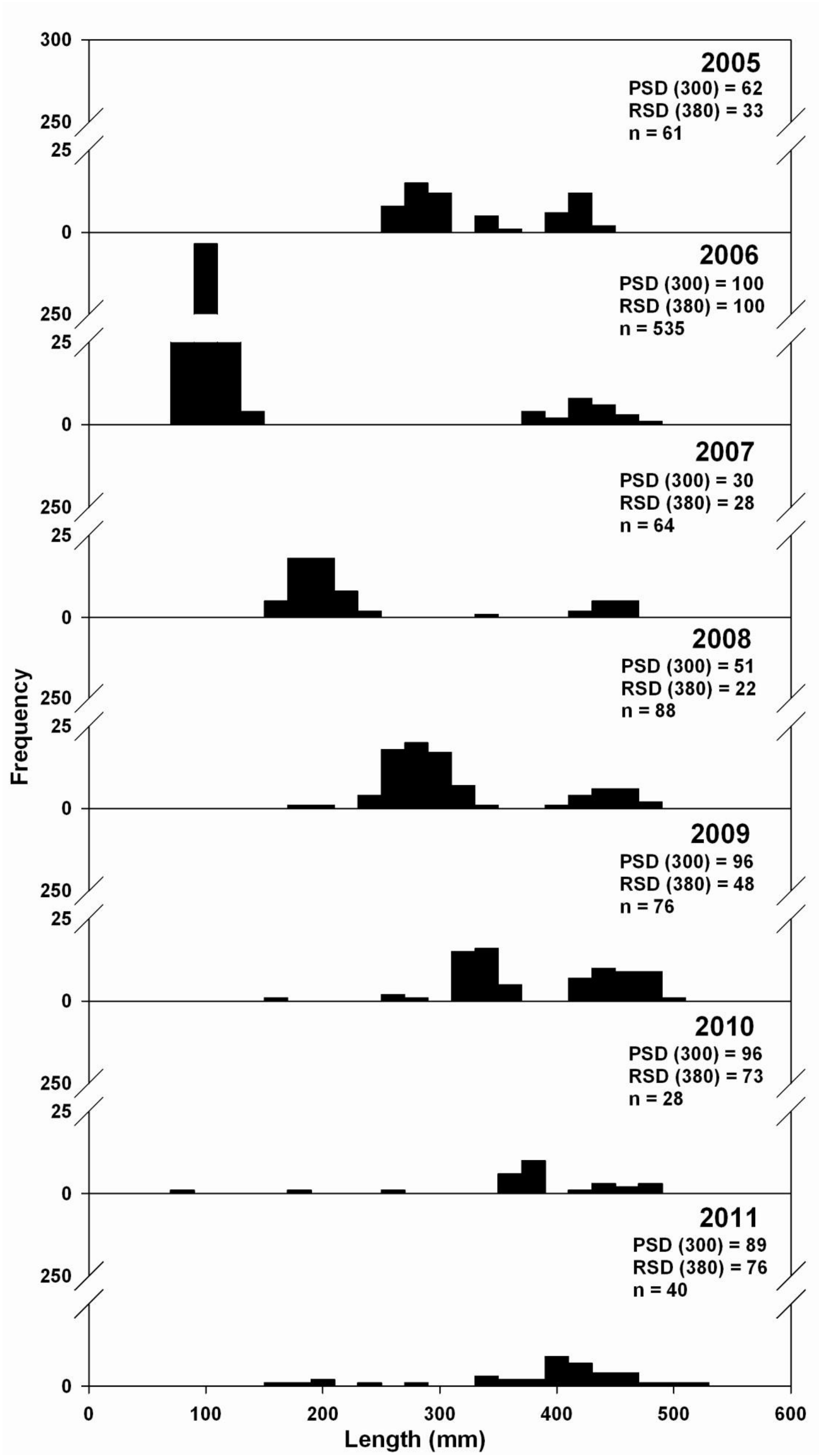


Figure E-12. Largemouth bass length frequency distribution (20-mm length groups) captured by electrofishing during the spring in Pelican Lake from 2005 to 2011.

Table E-4. Largemouth bass mean relative weight ($W_r$) with standard error (SE) in parenthesis by length category captured by electrofishing in Pelican Lake from 1992 to 2011.

| Year | ≥ Stock Overall *Wr* | Stock - Quality (200-300 mm) (8-12 in) | Quality - Preferred (300-380 mm) (12-15 in) | Preferred - Memorable (380-510 mm) (15-20 in) | Memorable - Trophy (510-630 mm) (20-25 in) |
|---|---|---|---|---|---|
| 2011 | 107 (1.6) | 107 (7.4) | 116 (1.9) | 105 (1.8) | 107 (5.0) |
| 2010 | 119 (1.4) | b | 126 (1.9) | 117 (1.7) | b |
| 2009 | 118 (1.2) | 116 (7.8) | 118 (2.2) | 118 (1.4) | b |
| 2008 | 108 (1.3) | 107 (1.7) | 107 (1.7) | 111 (3.2) | b |
| 2007 | 117 (2.1) | 111 (2.0) | 130 (5.0) | 123 (4.0) | b |
| 2006 | 108 (3.0) | b | b | 108 (3.0) | b |
| 2005 | 103 (2.2) | 103 (3.3) | 92 (4.8) | 113 (1.8) | b |
| 2004 | 120 (4.0) | 136 (6.6) | b | 114 (4.1) | b |
| 2003 | 124 (2.4) | b | b | 125 (2.5) | b |
| 2002 | a | a | a | a | a |
| 2001 | 123 (5.2) | 138 (0.4) | b | 120 (3.3) | b |
| 2000 | 118 (1.2) | 131 (6.1) | 115 (1.3) | 120 (1.7) | b |
| 1999 | 124 (1.4) | 125 (2.2) | 125 (2.1) | 122 (3.6) | b |
| 1998 | 128 (1.4) | 126 (1.9) | 126 (2.1) | 133 (3.2) | b |
| 1997 | 125 (2.4) | 124 (2.7) | 119 (7.2) | 131 (5.7) | b |
| 1996 | 133 (2.0) | 135 (1.8) | b | 125 (8.7) | b |
| 1995 | 128 (5.2) | 139 (16.6) | 125 (3.1) | 122 (5.2) | b |
| 1994 | 135 (1.9) | 128 (6.1) | 141 (2.3) | 131 (2.9) | 126 (0.8) |
| 1993 | 125 (6.2) | 128 (6.4) | b | 123 (11.1) | b |
| 1992 | 129 (2.0) | 131 (1.9) | b | 122 (0.1) | b |

a = Sampling did not occur or weights were not recorded during that year.
b = Category had less than two samples for mean and SE calculations, but may have been calculated in overall $W_r$.

## Yellow perch

Yellow perch gill net mean CPUE in 2011 slightly decreased from 2010 levels (Figure E-13), while mean CPUE in trap nets increased from 2010 to a six year high (Figure E-14). For the second consecutive year Pelican Lake had a high abundance of preferred to memorable and memorable to trophy length fish (Figure E-15). Mean $W_r$ for yellow perch ≥ stock length was the second highest among refuge lakes sampled in 2011 (Table E-5).

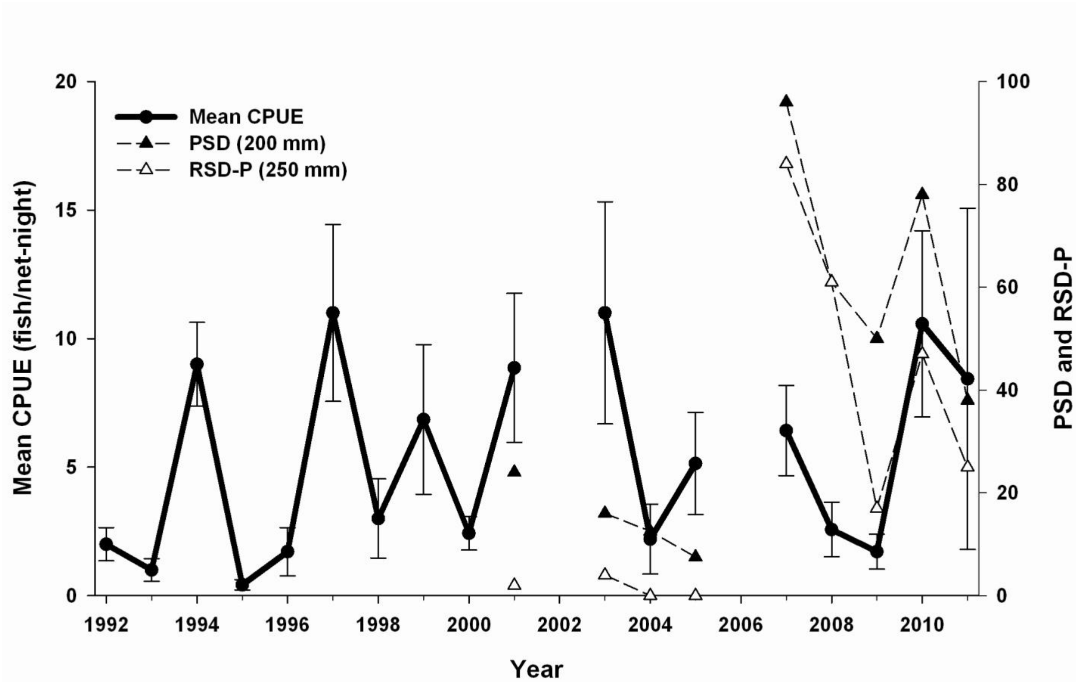


Figure E-13. Annual relative abundance (fish/net-night with SE bars), proportional size distribution (PSD), and relative size distribution (RSD-P) of yellow perch captured by gill nets during the fall in Pelican Lake from 1992 to 2011. Mean catch per unit effort (CPUE) calculated for yellow perch ≥ stock length (130 mm) only.

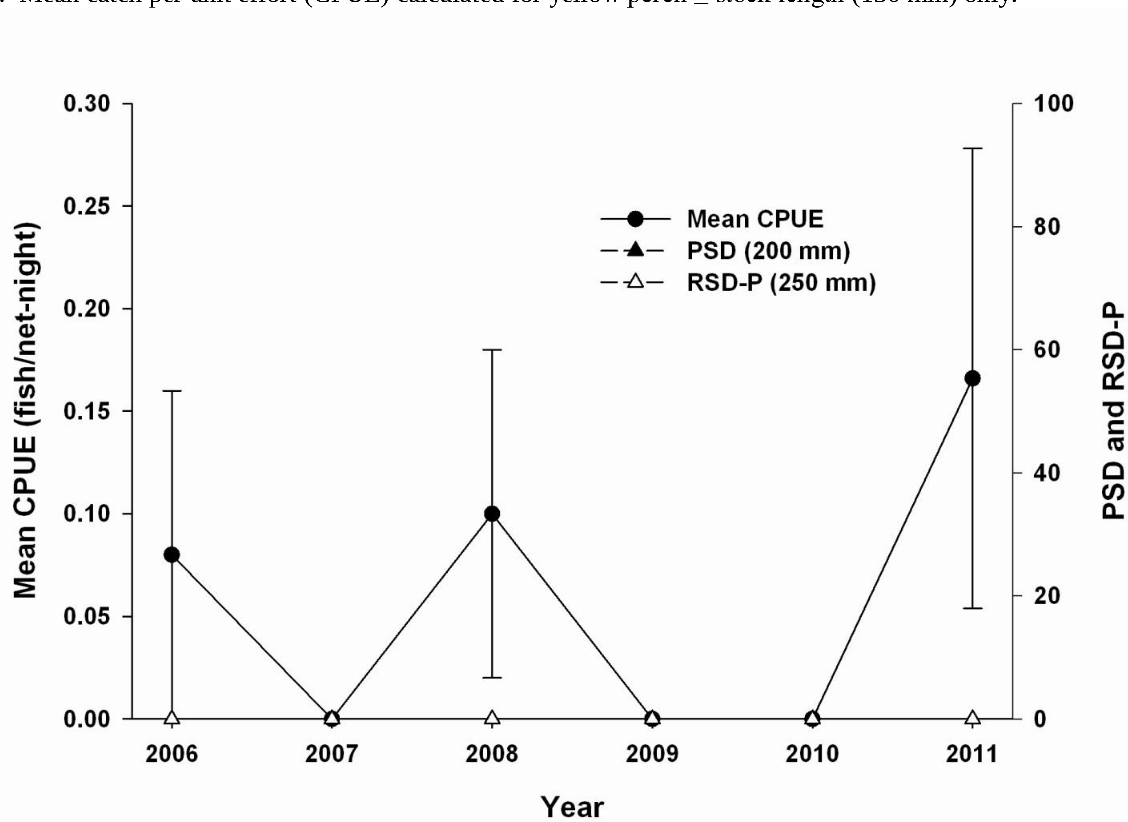


Figure E-14. Annual relative abundance (fish/net-night with SE bars), proportional size distribution (PSD), and relative size distribution (RSD-P) of yellow perch captured by trap nets during the spring in Pelican Lake from 2006 to 2011. Mean catch per unit effort (CPUE) calculated for yellow perch ≥ stock length (130 mm) only.

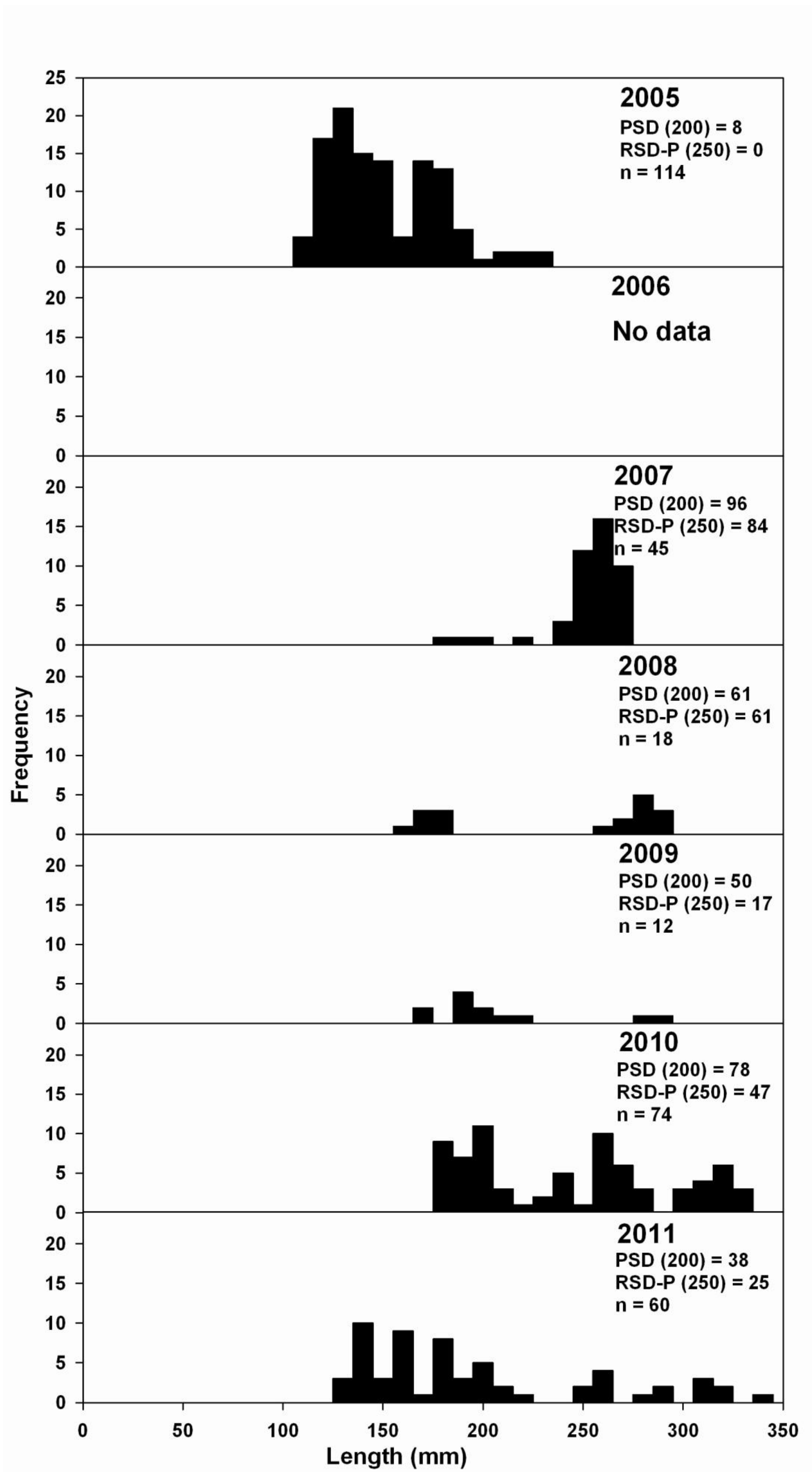


Figure E-15. Length frequency distribution (10-cm length groups) of yellow perch captured by gill nets during the fall in Pelican Lake from 2005 to 2011. Gill nets were not deployed in 2006 due to inaccessibility during low water.

Table E-5. Yellow perch mean relative weight ($W_r$) with standard error (SE) in parenthesis by length category captured by gill nets during the fall in Pelican Lake from 1992 to 2011.

| Year | ≥ Stock Overall $W_r$ | Stock - Quality (130-200 mm) (5-8 in) | Quality - Preferred (200-250 mm) (8-10 in) | Preferred - Memorable (250-300 mm) (10-12 in) | Memorable - Trophy (300-380 mm) (12-15 in) |
|---|---|---|---|---|---|
| 2011 | 97 (0.8) | 98 (1.0) | 95 (2.1) | 97 (2.5) | 96 (1.9) |
| 2010 | 99 (1.2) | 95 (2.3) | 100 (1.9) | 100 (3.2) | 101 (1.6) |
| 2009 | 97 (2.1) | 99 (1.4) | 95 (5.4) | 93 (7.8) | b |
| 2008 | 94 (2.2) | 94 (2.5) | 86 (3.9) | 103 (2.2) | b |
| 2007 | 97 (1.3) | 92 (2.5) | 102 (4.9) | 97 (0.9) | b |
| 2006 | a | a | a | a | a |
| 2005 | 98 (0.9) | 99 (1.0) | 97 (2.3) | b | b |
| 2004 | 100 (5.7) | 92 (1.7) | 109 (11.6) | b | b |
| 2003 | 102 (1.9) | 103 (2.6) | 97 (2.4) | 109 (8.7) | b |
| 2002 | a | a | a | a | a |
| 2001 | 97 (1.6) | 99 (2.0) | 92 (2.3) | b | b |
| 2000 | 100 (4.5) | 98 (2.8) | 118 (32.4) | b | 96 (5.5) |
| 1999 | 94 (1.2) | 94 (1.3) | b | 90 (3.6) | b |
| 1998 | 98 (2.3) | 97 (3.4) | b | 99 (4.0) | 97 (2.8) |
| 1997 | 96 (1.0) | 96 (1.3) | 95 (1.7) | 99 (3.3) | 99 (7.0) |
| 1996 | 95 (2.8) | 91 (1.6) | b | 112 (8.7) | b |
| 1995 | 87 (3.9) | 91 (2.8) | b | b | b |
| 1994 | 100 (2.3) | 95 (2.3) | 112 (3.7) | b | 121 (0.4) |
| 1993 | 97 (6.0) | 96 (9.5) | 97 (3.2) | b | b |
| 1992 | 93 (1.4) | 92 (1.4) | b | b | b |

a = Sampling did not occur or weights were not recorded during that year.
b = Category had less than two samples for mean and SE calculations, but may have been calculated in overall $W_r$.

# Summary

Common carp – Trap and gill net CPUE estimates remained low but demonstrated a slight upward trend, while the population structure was similar to 2010, it consisted mainly of large adults.

Northern pike – Relative abundance and size structure remained similar to the previous four years (2007 – 2010) with an increased number of fish beginning to transition into the memorable length category.

Bluegill **–** Relative abundance substantially increased and the size structure improved.

Largemouth bass – Relative abundance slightly increased but the size structure remained out of balance. The fishery was dominated by quality length (≥ 300 mm) fish.

Yellow perch – Relative abundance increased slightly in gill nets while mean CPUE in trap nets decreased slightly. Length distribution increased in 2011 indicating recruitment from the 2010 year class.

## Management Recommendations

1. Continue the 28 in maximum size limit for northern pike. Encourage catch and release for northern pike to maintain and increase the adult population.

2. Continue to improve boat ramp accessibility. Extend dock past vegetation or remove vegetation to improve fishing opportunities from the new dock.

3. Add signs near lake access points to inform anglers of the illegal activity of moving fish from one lake to another.

4. Continue annual surveys.

# WATTS LAKE

## Lake Description

Watts Lake is adjacent to Highway 16B and about 0.3 miles east of the Hackberry Lake headquarters. The lake is easily accessible from the highway and receives considerable fishing pressure, especially during the times that the other refuge lakes are inaccessible. The lake develops dense submergent vegetation during late spring through fall and this curtails fishing during this time. Watts Lake has no inlet and the lake is held artificially high by a water control structure on the east end.

Watts Lake was last renovated during 1976 and re-stocked the following year (Appendix A). No common carp were detected since the renovation until one was captured in 2005. During 1987, the lake was opened to muskellunge and largemouth bass harvest. Muskellunge were susceptible to harvest and many were harvested. For muskellunge and largemouth bass, Watts Lake was designated as a brood stock lake and managed as a catch-and-release fishery until 2007 (Appendix B). An over abundance of slow growing yellow perch were noted during 1989 surveys and 80 male northern pike were transplanted in an attempt to control yellow perch recruitment for improved growth rates and size class distribution. The 1992 surveys did not indicate that the northern pike had controlled yellow perch recruitment, therefore saugeye (i.e., sauger *Sander canadense* X walleye *S. vitreum* hybrids) were stocked during 1994, 1995, and 1996 (Appendix A) to add additional predators. The fishery includes yellow perch, largemouth bass, bluegill, orangespotted sunfish (*Lepomis humilis*), green sunfish (*Lepomis cyanellus*), grass pickerel (*Esox americanus*), northern pike, saugeye, black bullhead, and common carp.

Watts Lake is 93 surface ha (230 ac); maximum depth is 2 m (6 ft.) with an average depth of 1.3 m (4 ft.) (Figure A-1). The lake is subject to winter-kills when heavy snow occurs early and then remains for extended periods. Winter-kills would occur more often if not for the many springs that occur in the lake. The bottom is relatively flat and about 60% silt and 40% sand. Much of the bottom is flocculent and nest builders such as bluegill and largemouth bass have limited spawning habitat. Emergent vegetation (e.g. cattail, bulrush, phragmites) dominate much of the shoreline making access difficult. The lake is essentially a large littoral area and submergent vegetation is dense during summer. Submergent vegetation includes sago pondweed, curly-leaf pondweed, coontail, and water milfoil. The surrounding watershed is sandy rolling grasslands and the primary land use is livestock grazing. The uplands adjacent to the lake are dominated by short grasses with a few cottonwoods and willows.

Water quality parameters collected were water temperature, dissolved oxygen, pH, salinity, alkalinity, and conductivity (Table 1). Specific conductivity averages 241 μS/cm, total alkalinity averages 149 mg/L, phenolphthalein alkalinity averages 12 mg/L, pH ranges from 8.5 during spring to 10.5 during late summer, and secchi disk readings average 1 m with water clarity limited more by phytoplankton blooms than turbidity. The lake is too shallow to develop a summer thermocline. Additionally, water chemistry analysis was performed to determine nitrite, nitrate, total nitrogen, ammonia, ortho-phosphorous, and total phosphorous levels for Watts Lake (Appendix I).

Table G-1. Watts Lake surface water quality parameters from 2001 to 2011.

| Date | Time | Water temp. (°C) | D.O. (mg/L) | Secchi depth (cm) | pH | Salinity (ppt) | Phenolphthalein alkalinity (mg/L) | Total alkalinity (mg/L) | Conductivity (µS/cm) |
|---|---|---|---|---|---|---|---|---|---|
| 08/2011 | | 26 | 14.6 | 38 | 9.4 | | 0 | 120 | 210 |
| 08/2009 | 1645 | 24 | 10.9 | | 9.1 | | 17 | 86 | 227 |
| 06/2011 | | 24 | 9.8 | | 8.2 | | 0 | 120 | 237 |
| 05/2009 | 1710 | 22 | 9.2 | 65 | 8.5 | | 0 | 119 | 277 |
| 05/2007 | | 17 | 9.2 | 110 | 7.7 | 0.1 | 17 | 103 | 229 |
| 06/2005 | | 20 | | | 7.1 | | 0 | 290 | 260 |
| 09/2001 | | 17 | | 40 | 7.2 | | 42 | 111 | 235 |
| 07/2001 | 0615 | 23 | 5.8 | | 8.8 | | 0 | 120 | |
| 07/2001 | 1910 | 26 | 12.9 | | 8.0 | | 0 | 120 | |

# Results and Discussion

## Common carp

A total of three common carp were collected in gill nets during 2011. Relative abundance of common carp in gill nets was one fish/net night (SE = 0.58). Lengths ranged from 592 – 631 mm (mean = 614 mm) for these preferred length fish. Relative weight ranged from 94 – 101 (mean = 97) demonstrating that these fish were in good physical condition. The first observation of common carp in Watts Lake was one sub-stock length fish captured in a gill net in 2005. In 2007, mean CPUE was 7 carp/gill net-night (SE = 2.5) and the size structure of the population was of adult fish that were all preferred length; no common carp were collected in 2009.

## Northern pike

A total of 18 northern pike were collected in gill nets (n = 14) and trap nets (n = 4) during 2011. Seventy-two percent of the fish captured in gill nets (n = 9) and trap nets (n = 4) were preferred length. Northern pike were first detected in Watts Lake in 2005. Since then, gill-net mean CPUE substantially increased (Figure G-1) and trap net mean CPUE increased in 2007 and has appeared to stabilize (Figure G-2). Mean *Wr* for northern pike captured in gill nets during 2011 (*Wr* = 91 [SE = 2.2]) was similar to 2009 (*Wr* = 96 [SE = 2.5]) and similar to other Refuge lakes sampled in 2011.

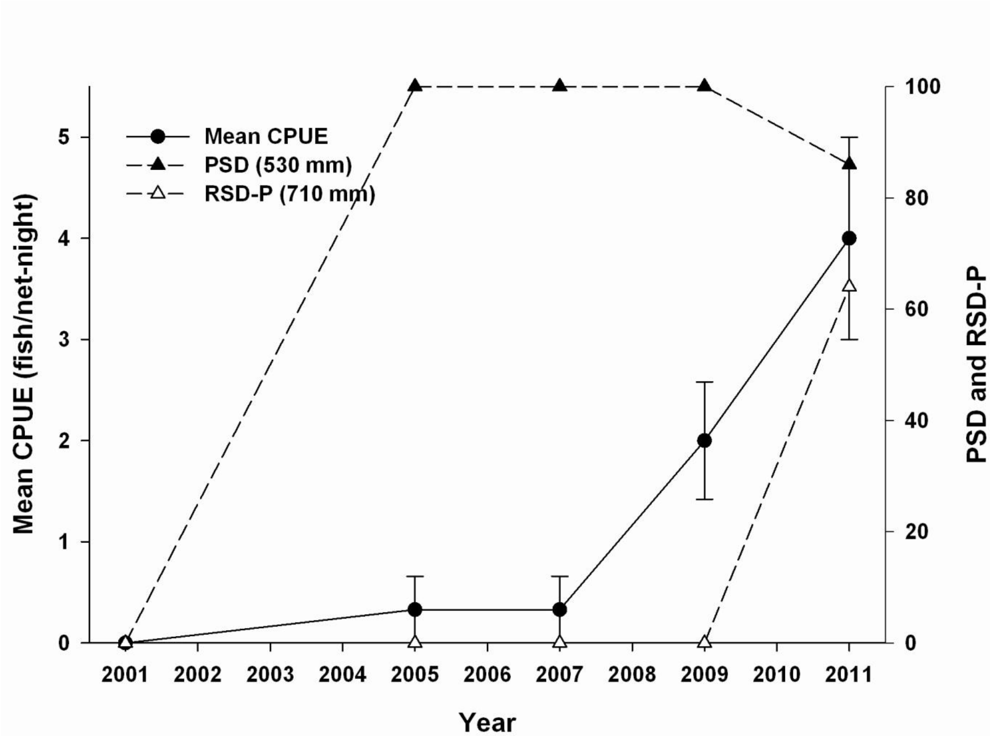


Figure G-1. Annual relative abundance (fish/net-night with SE bars), proportional size distribution (PSD), and relative size distribution (RSD-P) of northern pike captured by gill nets during the spring in 2001 and during the fall in 2005, 2007, 2009, and 2011 in Watts Lake. Mean catch per unit effort (CPUE) calculated for northern pike ≥ stock length (350 mm) only.

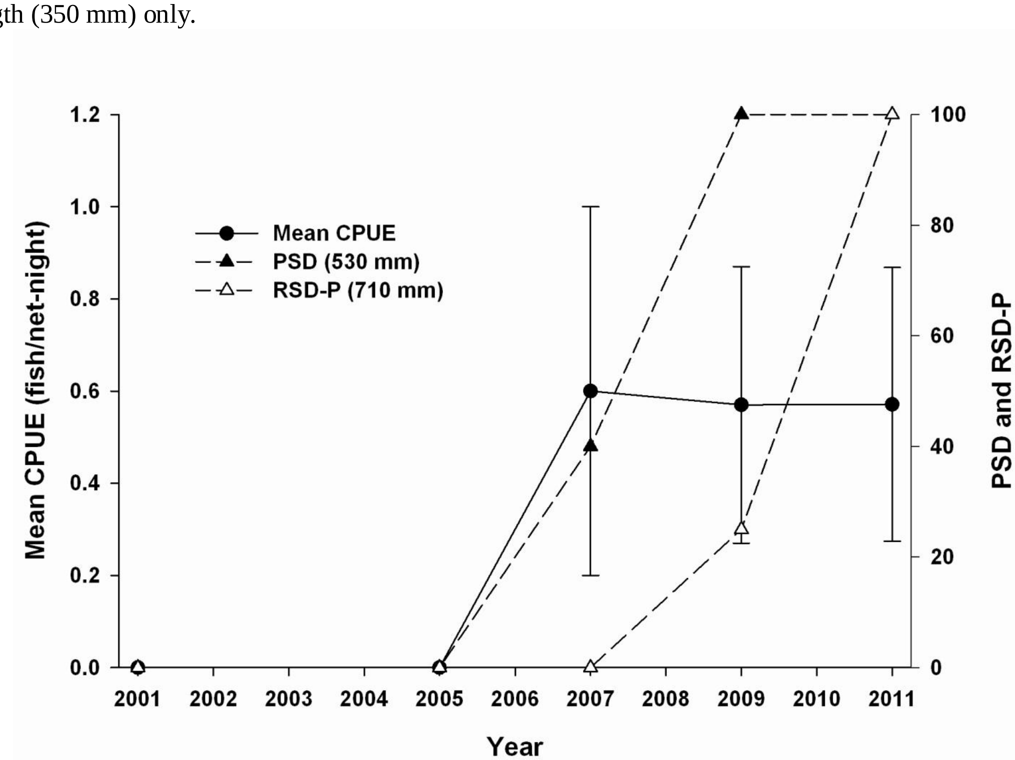


Figure G-2. Annual relative abundance (fish/net-night with SE bars), proportional size distribution (PSD), and relative size distribution (RSD-P) of northern pike captured by trap nets during the spring in Watts Lake in 2001, 2005, 2007, 2009, and 2011. Mean catch per unit effort (CPUE) calculated for northern pike ≥ stock length (350 mm) only.

**Black bullhead**

Twenty-three black bullheads were collected in gill nets that ranged from 194 – 337 mm (mean = 299; SE = 6.3). During 2009 nine black bullheads were collected in gill nets. The first year this species was captured in Watts Lake was 2007 with two black bullheads collected. Relative weight for preferred and quality length fish was 110 and 112, respectively. A single stock length fish was collected indicating recent recruitment.

**Bluegill**

Bluegill relative abundance has continued to increase following the 2005 sampling year, after a suspected winter-kill (Figures G-3 and G-4). Watts Lake had the second highest density of bluegills in 2011 among the Refuge lakes, preceded only by Dewey. Bluegill length range was similar to 2009 (Figure G-5), while the size structure improved with fish transitioning into larger length classes as well as recruitment of smaller length fish. Bluegills in all length classes were in good physical condition during 2011 (Table G-2).

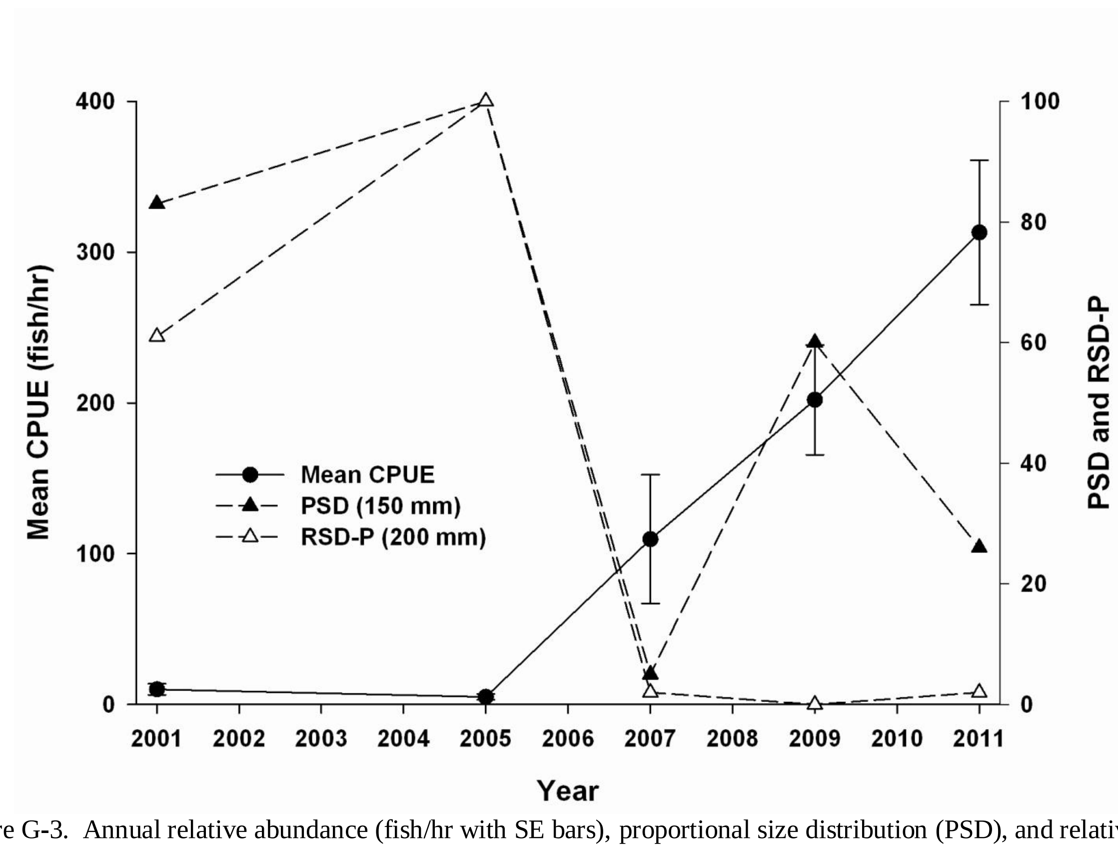


Figure G-3. Annual relative abundance (fish/hr with SE bars), proportional size distribution (PSD), and relative size distribution (RSD-P) of bluegills sampled by electrofishing during the spring in Watts Lake in 2001, 2005, 2007, 2009, and 2011. Mean catch per unit effort (CPUE) calculated for bluegill ≥ stock length (80 mm) only.

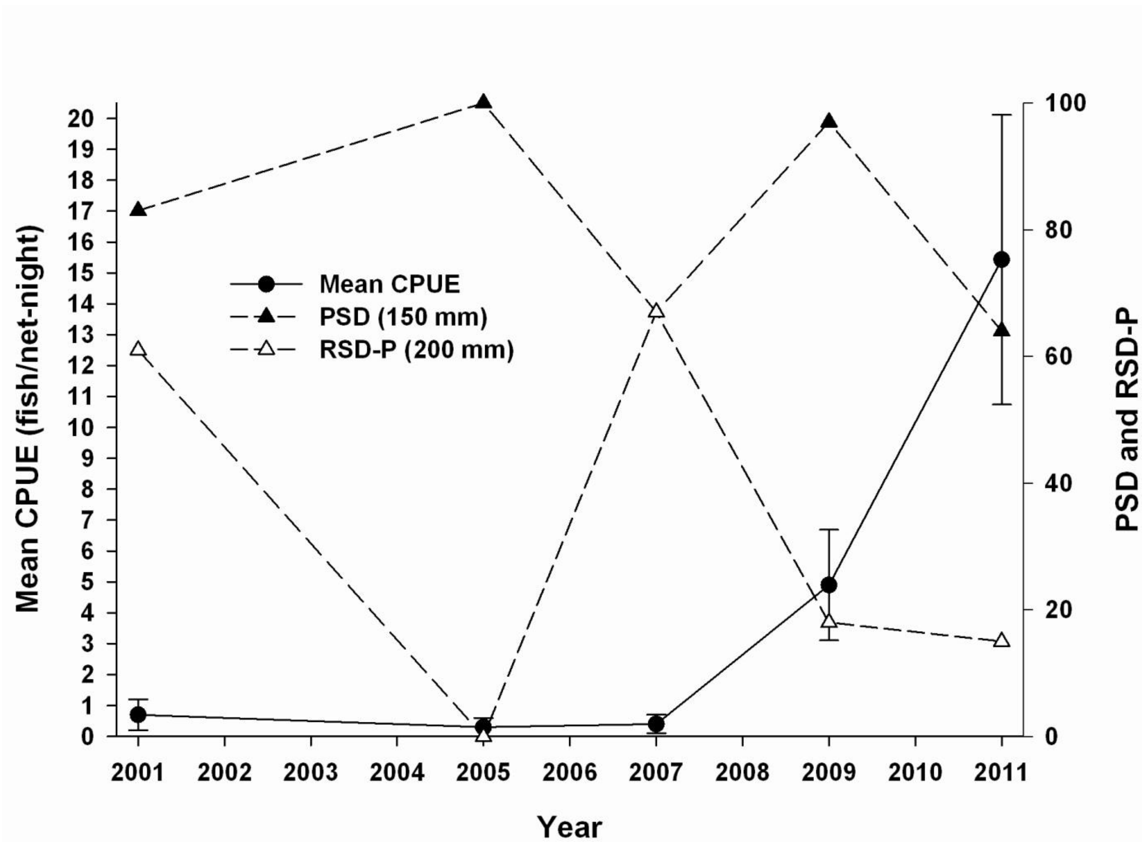

Figure G-4. Annual relative abundance (fish/net-night), proportional size distribution (PSD), and relative size distribution (RSD-P) of bluegills captured by trap nets during the spring in Watts Lake during 2001, 2005, 2007, 2009, and 2011. Mean catch per unit effort (CPUE) calculated for bluegill ≥ stock length (80 mm) only.

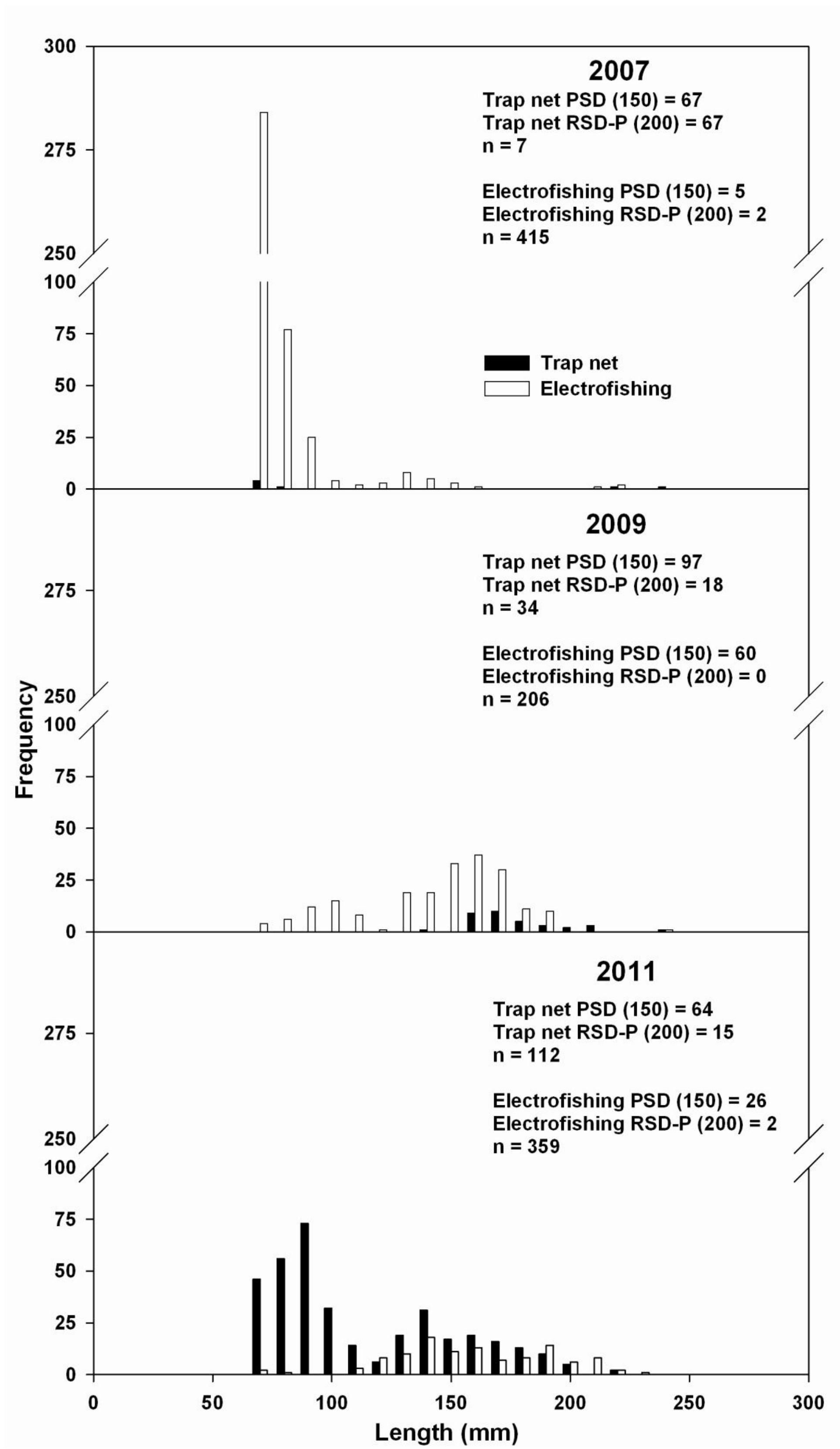


Figure G-5. Length frequency distribution (10-mm length groups) for bluegills captured by trap nets (black bars) and electrofishing (white bars) during the spring in Watts Lake in 2007, 2009, and 2011.

Table G-2. Bluegill mean relative weight ($W_r$) with standard error (SE) in parenthesis by length category that were captured by trap nets and electrofishing during the spring in Watts Lake from 1992 to 2011.

| Year | ≥ Stock Overall $W_r$ | Stock - Quality (80-150 mm) (3-6 in) | Quality - Preferred (150-200 mm) (6-8 in) | Preferred - Memorable (200-250 mm) (8-10 in) | Memorable - Trophy (250-300 mm) (10-12 in) |
|---|---|---|---|---|---|
| 2011 | 110 (1.4) | 106 (2.1) | 114 (2.4) | 111 (2.1) | b |
| 2009 | a | a | a | a | a |
| 2008 | a | a | a | a | a |
| 2007 | 127 (1.9) | 127 (2.2) | 123 (2.8) | 137 (6.7) | b |
| 2006 | a | a | a | a | a |
| 2005 | b | b | b | b | b |
| 2004 | a | a | a | a | a |
| 2003 | a | a | a | a | a |
| 2002 | a | a | a | a | a |
| 2001 | 116 (3.4) | 113 (4.6) | 104 (9.6) | 121 (3.4) | b |
| 2000 | a | a | a | a | a |
| 1999 | a | a | a | a | a |
| 1998 | 119 (3.9) | 136 (3.3) | 106 (4.9) | 104 (7.1) | b |
| 1997 | a | a | a | a | a |
| 1996 | 130 (3.1) | 118 (6.4) | 133 (4.8) | 136 (2.6) | b |
| 1995 | a | a | a | a | a |
| 1994 | a | a | a | a | a |
| 1993 | a | a | a | a | a |
| 1992 | 113 (3.7) | 111 (4.7) | 123 (2.6) | 111 (11.5) | b |

a = Sampling did not occur or weights were not recorded during that year.
b = Category had less than two samples for mean and SE calculations, but may have been calculated in overall $W_r$.

## Golden shiner

In 2011, four golden shiners were collected in gill nets, a decrease of five fish from 2009. Lengths of golden shiners ranged from 140 to 149 mm (mean = 145; SE = 2.0).

## Largemouth bass

Largemouth bass relative abundance (Figure G-6) continues to improve each year since Watts Lake had a winter-kill in 2005. However, the proportion of larger (≥ 300 mm) fish has declined since 2009. Electrofishing CPUE estimates of largemouth bass in Watts Lake was the highest among all refuge lakes sampled in 2011. Based on multiple modes in length frequency histogram, multiple year classes are recruiting to larger lengths (Figure G-7). Mean Wr was excellent (Table G-3).

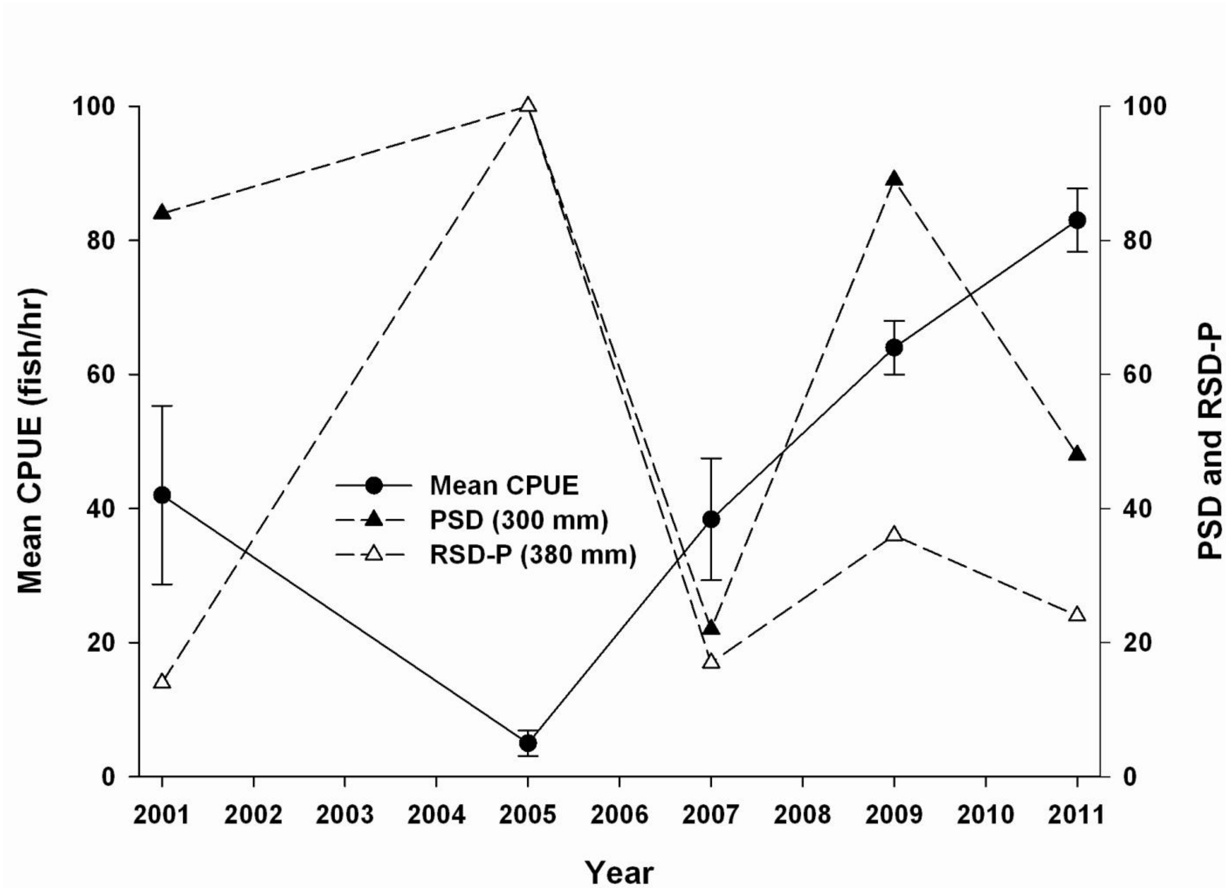


Figure G-6. Annual relative abundance (fish/hr with SE bars), proportional size distribution (PSD), and relative size distribution (RSD-P) of largemouth bass captured by electrofishing in Watts Lake in 2001, 2005, 2007, 2009, and 2011. Mean catch per unit effort (CPUE) calculated for largemouth bass ≥ stock length (200 mm) only.

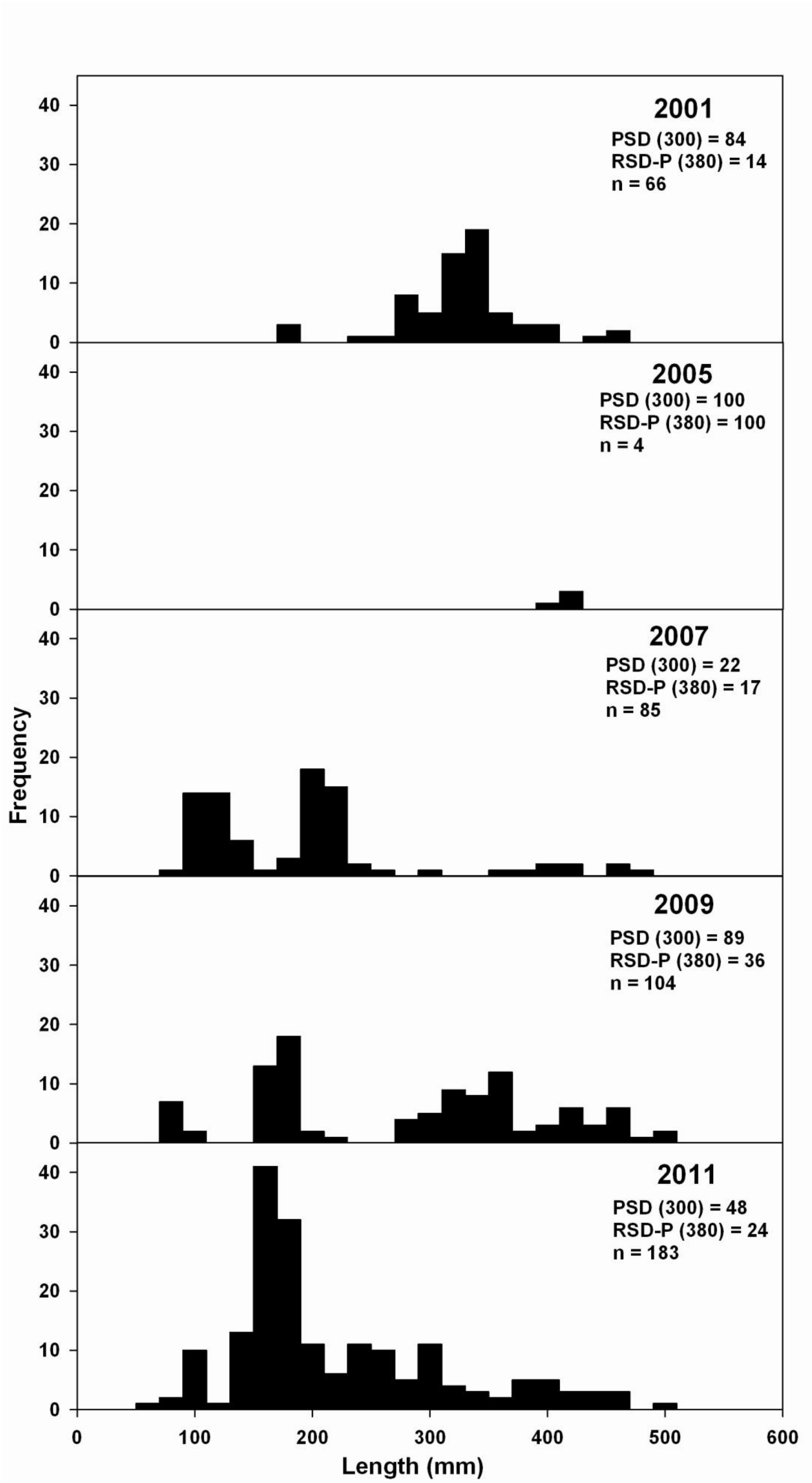


Figure G-7. Largemouth bass length frequency distribution (10-mm length groups) captured by electrofishing during the spring in Watts Lake in 2001, 2005, 2007, 2009, and 2011.

Table G-3. Largemouth bass mean relative weight ($W_r$) with standard error (SE) in parenthesis by length category captured by electrofishing during the spring in Watts Lake from 1992 to 2011.

| Year | ≥ Stock Overall $W_r$ | Stock - Quality (200-300 mm) (8-12 in) | Quality - Preferred (300-380 mm) (12-15 in) | Preferred - Memorable (380-510 mm) (15-20 in) | Memorable - Trophy (510-630 mm) (20-25 in) |
|---|---|---|---|---|---|
| 2011 | 107 (2.2) | 104 (2.0) | 109 (7.5) | 112 (2.4) | b |
| 2009 | 120 (1.5) | 118 (6.4) | 120 (1.6) | 119 (2.5) | b |
| 2008 | a | a | a | a | a |
| 2007 | 119 (1.4) | 116 (1.6) | 120 (2.5) | 122 (3.2) | b |
| 2006 | a | a | a | a | a |
| 2005 | 129 (3.2) | b | 136 (12.3) | 128 (3.4) | b |
| 2004 | a | a | a | a | a |
| 2003 | a | a | a | a | a |
| 2002 | a | a | a | a | a |
| 2001 | 101 (1.6) | 103 (1.8) | 101 (2.4) | 100 (2.4) | b |
| 2000 | a | a | a | a | a |
| 1999 | a | a | a | a | a |
| 1998 | a | a | a | a | a |
| 1997 | a | a | a | a | a |
| 1996 | 113 (2.6) | 112 (2.8) | 107 (2.8) | 127 (4.3) | b |
| 1995 | a | a | a | a | a |
| 1994 | a | a | a | a | a |
| 1993 | a | a | a | a | a |
| 1992 | 108 (2.0) | 120 (3.2) | 112 (6.8) | 105 (2.1) | b |

a = Sampling did not occur during that year.
b = Category had less than two samples for mean and SE calculations.

## Saugeye

No saugeye were captured in Watts Lake in 2009 and 2011. The saugeye population is either extirpated or at such low levels that they were not detected. About 20,000 saugeye were stocked in Watts Lake from 1994 to 1996 to control the overabundant yellow perch population. Gill net data for Watts Lake in 1996, 2001, 2005, and 2007 all indicated a declining and aging population since the last stocking.

## Yellow perch

In 2005 and 2007, the yellow perch population appeared to have recovered from extremely low gill net and trap net levels in 2001. In 2011, gill net relative abundance was similar to 2009, while both PSD and RSD-P increased slightly (Figure G-8), whereas trap net CPUE and PSD increased (Figure G-9). The length frequency distribution indicates that low levels of spawning and recruitment has occurred for multiple years (Figure G-10). Mean *Wr* for stock length fish was highest of all Refuge lakes sampled in 2011. However, quality and preferred length yellow perch had the lowest *Wr* among all lakes sampled. Watts Lake has historically had the lowest overall mean *Wr* for fish ≥ stock length for yellow perch among refuge lakes (Table G-4).

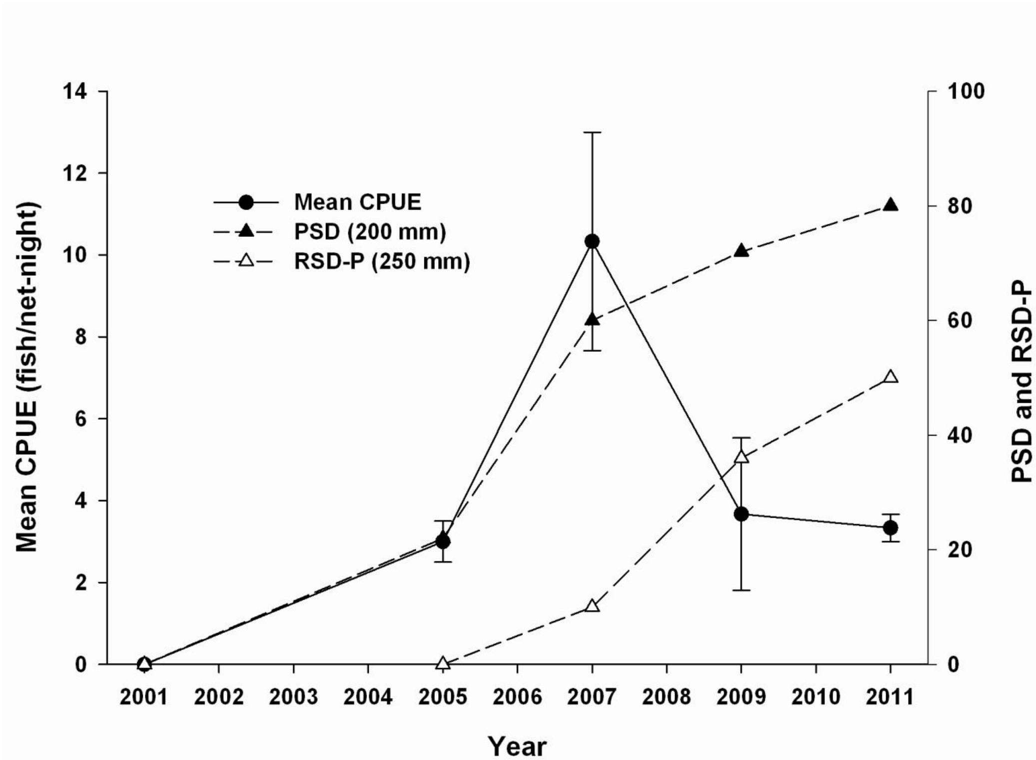


Figure G-8. Annual relative abundance (fish/net with SE bars), proportional size distribution (PSD), and relative size distribution (RSD-P) of yellow perch captured by gill nets in Watts Lake in 2001, 2005, 2007, 2009, and 2011. Mean catch per unit effort (CPUE) calculated for yellow perch ≥ stock length (130 mm) only.

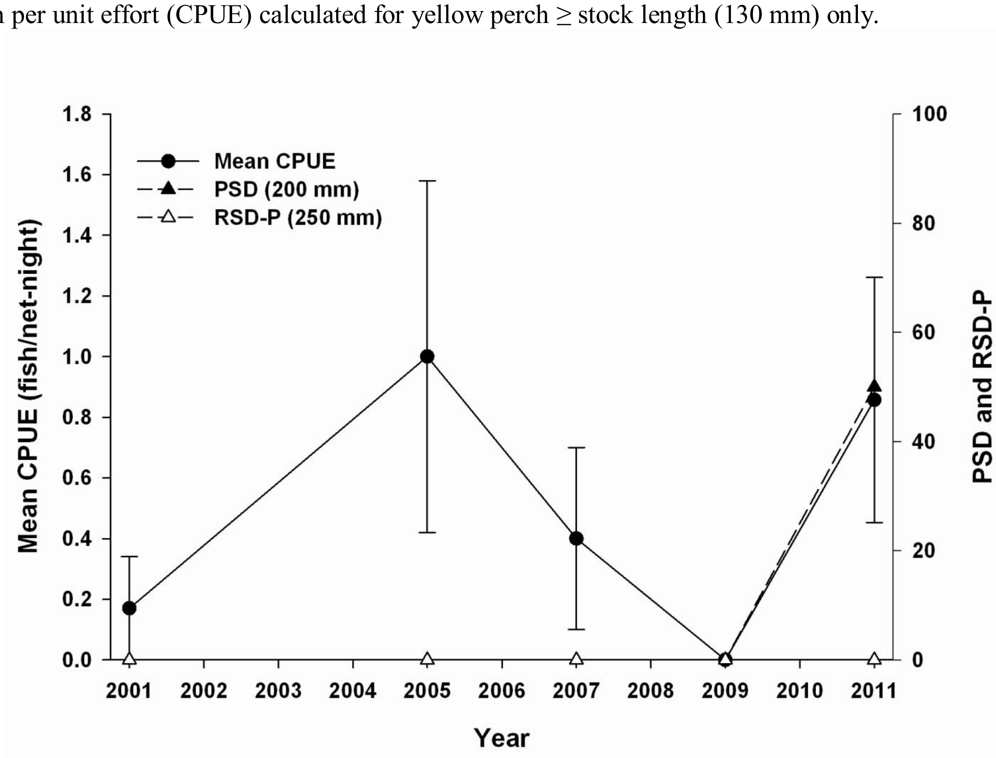


Figure G-9. Annual relative abundance (fish/net-night with SE bars), proportional size distribution (PSD), and relative size distribution (RSD-P) of yellow perch captured by trap nets during the spring in Watts Lake during 2001, 2005, 2007, 2009, and 2011. Mean catch per unit effort (CPUE) calculated for yellow perch ≥ stock length (130 mm) only.

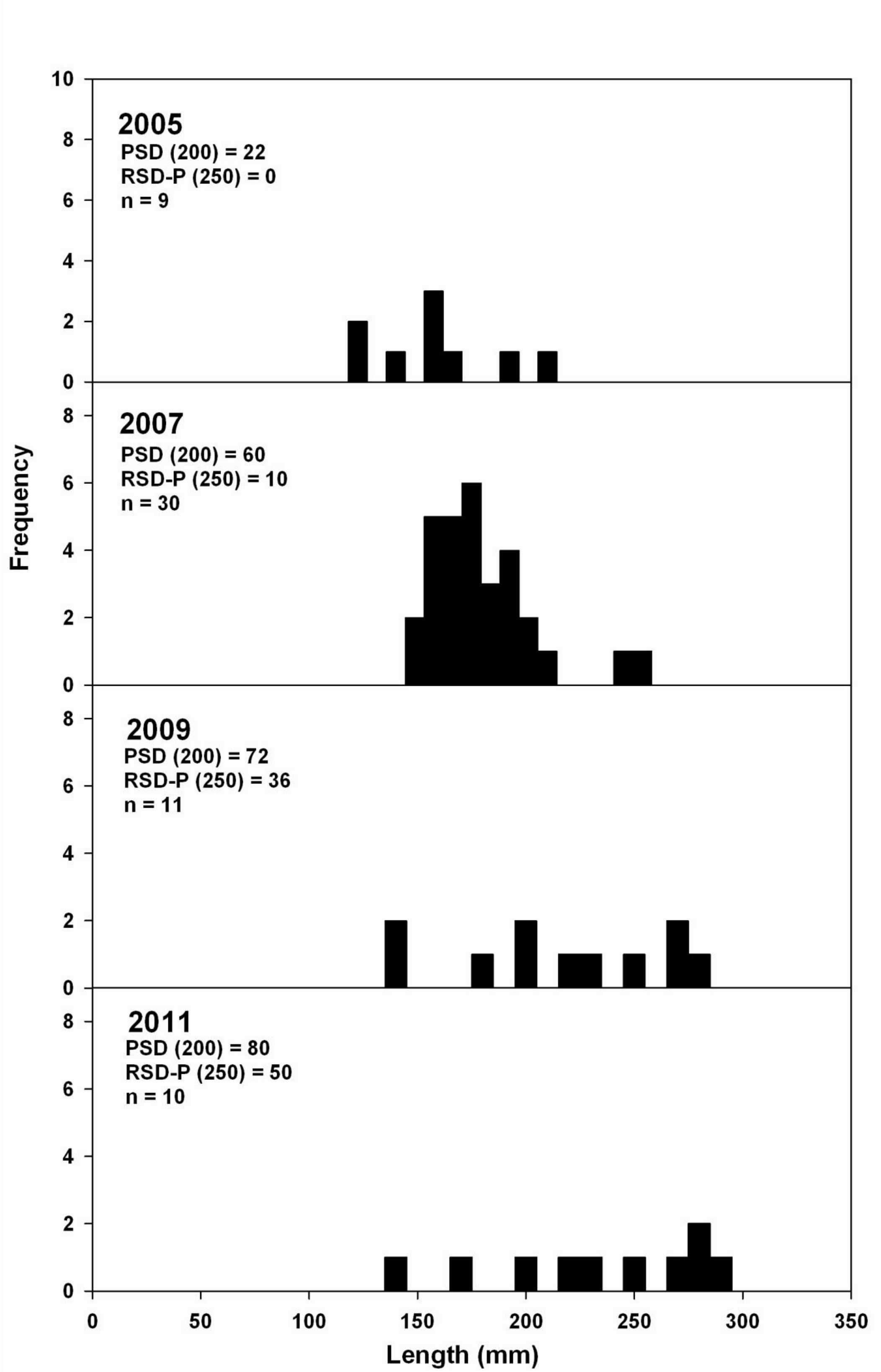


Figure G-10. Length frequency distribution (10-mm length group) for yellow perch captured in gill nets during the fall in Watts Lake in 2005, 2007, 2009, and 2011.

Table G-4. Yellow perch mean relative weight (*Wr*) with standard error (SE) in parenthesis by length category captured by gill nets during the fall in Watts Lake from 1992 to 2011.

| Year | ≥ Stock<br>Overall $W_r$ | Stock - Quality<br>(130-200 mm)<br>(5-8 in) | Quality - Preferred<br>(200-250 mm)<br>(8-10 in) | Preferred - Memorable<br>(250-300 mm)<br>(10-12 in) | Memorable - Trophy<br>(300-380 mm)<br>(12-15 in) |
|---|---|---|---|---|---|
| 2011 | 84 (5.3) | 100 (6.7) | 83 (7.9) | 79 (8.4) | b |
| 2010 | a | a | a | a | a |
| 2009 | 92 (2.0) | 95 (5.9) | 92 (3.0) | 89 (2.11) | b |
| 2008 | a | a | a | a | a |
| 2007 | 92 (1.2) | 95 (1.6) | 90 (1.7) | 88 (6.5) | b |
| 2006 | a | a | a | a | a |
| 2005 | 95 (2.0) | 97 (2.1) | 90 (0.1) | b | b |
| 2004 | a | a | a | a | a |
| 2003 | a | a | a | a | a |
| 2002 | a | a | a | a | a |
| 2001 | b | b | b | b | b |
| 2000 | a | a | a | a | a |
| 1999 | a | a | a | a | a |
| 1998 | 91 (1.4) | 93 (2.0) | 90 (1.8) | 85 (5.1) | b |
| 1997 | a | a | a | a | a |
| 1996 | 103 (2.7) | 104 (3.9) | 104 (3.7) | 84 (2.2) | b |
| 1995 | a | a | a | a | a |
| 1994 | a | a | a | a | a |
| 1993 | a | a | a | a | a |
| 1992 | 86 (1.6) | 89 (2.7) | 84 (1.3) | 80 (1.9) | 69 (0.7) |

a = Sampling did not occur during that year.
b = Category had less than two samples for mean and SE calculations.

# Summary

Common carp – The common carp population remains at a low density with no recent evidence suggesting recruitment.

Northern pike – Relative abundance of northern pike is likely still increasing but starting to stabilize.

Black bullhead – The black bullhead population appears to continue to increase after first being detected in 2007.

Bluegill – In 2011, Watts Lake had the second highest density of bluegill among Refuge lakes with few fish of preferred length.

Golden shiners – Trap nets and gill nets detected golden shiners indicating the presence of this alternative prey species.

Largemouth bass – Relative abundance and size structure has continued to improve following a winter-kill in 2005. Consistent spawning and recruitment was also occurring in Watts Lake.

Saugeye – For the second consecutive sampling year (2009 and 2011) no saugeyes were collected indicating that the population is either extirpated or at such low levels that they were not detected.

Yellow perch – Mean gill net relative abundance remains similar to 2009 levels, while trap net mean CPUE increased from 2007 and 2009. Multiple year classes of yellow perch were collected with some fish being of preferred length.

## Management Recommendations

1. Consider supplemental stocking of saugeye as an additional game fish species.

3. Consider collecting northern pike and moving these fish to Clear, Dewey, or Hackberry lakes.

4. Continue fishery surveys every odd year (i.e., 2013).

5. Improve handicap fishing access. Include a large concrete pad for parking and wheel chair access. Extend handicap accessible ramp to deep waters. Construct a new, roomier dock for handicap access.

# Acknowledgements

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**Appendix A.** Fish stocking history for Valentine National Wildlife Refuge lakes. Multiple life stages (sizes) were stocked: FY = fry (Hatch to 1.49 in.); FG = fingerlings (1.5 to 5.49 in.); AD = adult (sexually mature, regardless of size); MX = mixed (transplanted from natural sources).

| | Largemouth bass | | | Bluegill | | | Northern pike | | | Yellow perch | | | Black crappie | | | Sauger X walleye | | | Muskellunge | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Month | N | Size | Month | N | Size | Month | N | Size | Month | N | Size | Month | N | Size | Month | N | Size | Month | N | Size |
| **Clear Lake** | | | | | | | | | | | | | | | | | | | | | |
| 2009 | | | | | | | Mar | 6 | AD | | | | | | | | | | | | |
| 2008 | | | | | | | Apr | 51 | AD | | | | | | | | | | | | |
| 2007 | | | | | | | Mar | 48 | AD | | | | | | | | | | | | |
| 2006 | | | | | | | | | | | | | Jun | 211,385 | FY | | | | | | |
| 2005 | | | | | | | Mar | 50 | AD | | | | Jul | 140,727 | FY | | | | | | |
| | | | | | | | | | | | | | Mar | 514 | FG | | | | | | |
| 2004 | | | | | | | | | | | | | Aug & Sep | 12,698 | FG | | | | | | |
| | | | | | | | | | | | | | Oct | 48 | AD | | | | | | |
| 1996 | | | | Oct | 45,000 | FG | | | | | | | | | | | | | | | |
| 1991 | Jul | 6,000 | FG | Aug | 50,000 | FY | | | | | | | | | | | | | | | |
| 1990 | Jul | 17,000 | FG | | | | | | | | | | | | | | | | | | |
| 1989 | Jul | 15,000 | FG | | | | | | | Sep | 3,000 | FG | Sep | 2,448 | FG | | | | | | |
| 1988 | | | | | | | | | | | | | Sep | 5,750 | FG | | | | | | |
| 1987 | | | | | | | | | | | | | Sep | 4,086 | FG | | | | | | |
| 1985 | Jul | 35,541 | FG | | | | | | | | | | | | | | | | | | |
| 1983 | | | | | | | | | | | | | | | | | | | | | |
| **Dad's Lake** | | | | | | | | | | | | | | | | | | | | | |
| 1987 | | | | | | | Apr | 150,000 | FY | | | | | | | | | | | | |
| **Dewey Lake** | | | | | | | | | | | | | | | | | | | | | |
| 2004 | Aug | 43 | AD | | | | Aug | 195 | AD | Aug | 150 | AD | | | | | | | | | |
| 1992 | | | | | | | | | | | | | | | | | | | | | |
| 1991 | Jul | 28,000 | FG | Aug | 50,000 | FY | | | | | | | | | | | | | | | |
| 1989 | | | | | | | Mar | 1,010 | AD | | | | | | | | | | | | |
| 1987 | | | | | | | Mar & Apr | 1,256 | AD | | | | | | | | | | | | |
| 1985 | | | | Sep | 50,000 | FY | | | | | | | | | | | | | | | |
| 1981[a] | | | | | | | | | | | | | | | | | | | | | |
| **Duck Lake** | | | | | | | | | | | | | | | | | | | | | |
| 1995 | | | | | | | | | | | | | | | | Jun | 4,000 | FY | | | |
| 1994 | | | | | | | | | | | | | | | | Apr | 4,000 | FG | | | |
| 1991 | Jul | 10,000 | FY | Aug | 30,000 | FY | | | | Jun | 20,000 | FY | | | | | | | | | |
| 1986 | | | | Aug | 25,000 | FY | | | | | | | | | | | | | | | |
| 1985 | | | | Sep | 38,000 | FY | | | | | | | | | | | | | | | |

Appendix A continued.

| Year | Largemouth bass | | | Bluegill | | | Northern pike | | | Yellow perch | | | Black crappie | | | Sauger X walleye | | | Muskellunge | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Month | N | Size | Month | N | Size | Month | N | Size | Month | N | Size | Month | N | Size | Month | N | Size | Month | N | Size |
| **Hackberry Lake** | | | | | | | | | | | | | | | | | | | | | |
| 2008 | | | | Sep | 52,445 | FG | | | | | | | | | | | | | | | |
| 2007 | Jun | 40,865 | FG | Mar & Sep | 179,194 | FG | | | | | | | | | | | | | | | |
| 2006 | | | | Oct | 364,315 | FG | | | | | | | | | | | | | | | |
| 2005 | Aug | 31 | AD | Oct | 148,070 | FG | | | | Jun | 136,000 | FY | | | | | | | | | |
| | May& Aug | 68,200 | FG | Feb & Mar | 128,000 | FG | | | | Apr | 1,400,000 | Egg | | | | | | | | | |
| | | | | | | | | | | Feb | 19,068 | FG | | | | | | | | | |
| 2004[a] | | | | Oct | 86,250 | FG | | | | | | | | | | | | | | | |
| 1996 | | | | Oct | 75,000 | FG | | | | | | | | | | | | | | | |
| 1992 | | | | | | | Apr | 1,200 | MX | | | | | | | | | | | | |
| 1991 | Aug | 35,000 | FG | | | | | | | | | | | | | | | | | | |
| 1990 | Jul | 35,000 | FG | | | | | | | | | | | | | | | | | | |
| 1989 | Aug | 37,000 | SA | | | | | | | | | | | | | | | | | | |
| 1986 | Jul | 30,000 | FG | Aug | 25,000 | FY | Mar | 203 | AD | | | | | | | | | | | | |
| | May | 107 | AD | | | | | | | | | | | | | | | | | | |
| 1985 | | | | Sep | 50,000 | FY | | | | | | | | | | | | | | | |
| **Pelican Lake** | | | | | | | | | | | | | | | | | | | | | |
| 2010 | | | | | | | Apr | 5 | AD | | | | | | | | | | | | |
| 1996 | | | | Oct | 102,800 | FG | | | | | | | | | | | | | | | |
| 1995 | | | | | | | | | | Apr | 2,000 | AD | | | | | | | | | |
| 1994 | | | | | | | Mar | 651 | AD | Apr | 59,981 | MX | | | | | | | | | |
| 1993 | | | | | | | | | | Apr | 5,651 | MX | | | | | | | | | |
| 1992 | Jun | 136,000 | FY | | | | | | | Apr | 1,100 | AD | | | | | | | | | |
| 1991 | Jul | 40,000 | FG | | | | | | | | | | | | | | | | | | |
| 1990 | Jul | 40,000 | FG | | | | | | | | | | | | | | | | | | |
| 1989 | Jul | 32,000 | FG | | | | | | | | | | | | | | | | | | |
| 1986 | | | | | | | Mar | 207 | AD | | | | | | | | | | | | |
| 1985 | | | | Sep | 50,000 | FY | | | | Apr | 7,660 | AD | | | | | | | | | |
| **Rice Lake** | | | | | | | | | | | | | | | | | | | | | |
| 2010 | Jun | 81 | AD | Jun | 42 | AD | | | | | | | | | | | | | | | |
| 2004 | | | | Mar | 26,048 | FY | | | | Mar | 3,326 | FG | | | | | | | | | |
| 2011 | | | | Sep | 24,440 | FG | | | | | | | | | | | | | | | |

Appendix A continued.

| | Largemouth bass | | | Bluegill | | | Northern pike | | | Yellow perch | | | Black crappie | | | Sauger X walleye | | | Muskellunge | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Month | N | Size | Month | N | Size | Month | N | Size | Month | N | Size | Month | N | Size | Month | N | Size | Month | N | Size |
| **Watts Lake** | | | | | | | | | | | | | | | | | | | | | |
| 2005 | Sep | 15,525 | FG | Oct | 148,070 | FG | | | | Aug | 19,261 | FG | | | | | | | | | |
| 1997 | | | | | | | | | | | | | | | | | | | Sep | 100 | SA |
| 1996 | | | | Oct | 30,000 | FG | | | | | | | | | | Jun | 10,000 | FG | Sep | 50 | SA |
| 1995 | | | | | | | | | | | | | | | | Jun | 5,000 | FG | | | |
| 1994 | | | | | | | | | | | | | | | | Apr | 5,000 | FG | | | |
| 1992 | Jun | 50,000 | FY | | | | | | | | | | | | | | | | | | |
| 1991 | Jul | 5,000 | FG | | | | | | | | | | | | | | | | | | |
| 1990 | Jul | 5,000 | FG | | | | May | 77 | AD | | | | | | | | | | | | |
| 1989 | Jul | 5,000 | FG | | | | | | | | | | | | | | | | | | |
| 1988 | | | | | | | | | | | | | | | | | | | Jun & Sep | 47 | AD |
| 1987 | | | | | | | | | | | | | | | | | | | Aug | 347 | AD |
| | | | | | | | | | | | | | | | | | | | May | 6,500 | FY |
| 1986 | | | | | | | | | | | | | | | | | | | Jun | 75 | FG |
| 1985 | | | | | | | | | | | | | | | | | | | Aug | 1,152 | SA |
| **West Long Lake** | | | | | | | | | | | | | | | | | | | | | |
| 1986 | | | | Aug | 25,000 | FY | | | | | | | | | | | | | | | |
| 1985 | | | | | | | | | | | | | | | | | | | | | |
| 1998 | Apr | 124 | AD | | | | | | | | | | | | | | | | | | |
| 1996 | Sep | 70 | AD | | | | | | | | | | | | | | | | | | |
| 1994 | | | | | | | | | | Apr | 2,241 | AD | | | | | | | | | |
| 1992 | | | | | | | | | | Apr | 1,100 | AD | | | | | | | | | |
| 1991 | Jul | 10,000 | FG | Aug | 20,000 | FG | | | | Jun | 30,000 | FG | | | | | | | | | |
| 1986 | Jul | 15,000 | FG | Aug | 25,000 | FY | | | | | | | | | | | | | | | |
| **Willow Lake** | | | | | | | | | | | | | | | | | | | | | |
| 2009 | | | | | | | | | | Sep | 35,750 | FG | | | | | | | | | |
| 1988 | | | | Aug & Sep | 116,000 | FG | Apr | 180,000 | FY | Apr | 4,000 | AD | | | | | | | | | |
| 2011 | | | | Sep | 149,400 | FY | | | | | | | | | | | | | | | |

[a] Lake renovation occurred during that year.

**Appendix B. Summary of fishing regulations.**

Fishing regulations on the Valentine National Wildlife Refuge. *Panfish species include bluegill, yellow perch, black crappie, green sunfish, orange-spotted sunfish, pumpkinseed, and all sunfish hybrids. **Panfish bag limit is in aggregate.

| Lake | Species | Year | Size limit | Bag limit** |
|---|---|---|---|---|
| Clear | Northern pike | 1993 – present | 28 in. max. | 3 |
| | | 1991 – 1992 | 36 in. min. | 3 |
| | | 1990 | 30 in. min. | 6 |
| | | 1988 – 1989 | 36 in. min. | 6 |
| | | 1987 | 24 in. min | 6 |
| | Largemouth bass | 2007 – present | 15 in. min. and 1 > 21 in. | 4 |
| | | 1988 – 2006 | 15 in. min. and 1 > 24 in. | 4 |
| | | 1987 | 12 in. min | 8 |
| | Panfish* | 2011 – present | | 15 |
| | | 1988 – 2010 | | 30 |
| | | 1987 | | No limit |
| | | | | |
| Dewey and Pelican | Northern Pike | 1993 – present | 28 in. max. | 3 |
| | | 1990 – 1992 | 36 in. min. | 3 |
| | | 1988 – 1989 | 36 in. min. | 6 |
| | | 1987 | 24 in. min. | 6 |
| | Largemouth bass | 2007 – present | 15 in. min. and 1 > 21 in. | 4 |
| | | 1988 – 2006 | 15 in. min. and 1 > 24 in. | 4 |
| | | 1987 | 12 in. min | 8 |
| | Panfish* | 2011 – present | | 15 |
| | | 1988 – 2010 | | 30 |
| | | 1987 | | No limit |
| | | | | |
| Hackberry | Northern pike | 1993 – present | 28 in. max. | 3 |
| | | 1992 | 36 in. min. | 3 |
| | | 1990 – 1991 | 24 in min. | 3 |
| | | 1987 – 1989 | 24 in. min. | 6 |
| | Largemouth bass | 2007 – present | 15 in. min. and 1 > 21 in. | 4 |
| | | 1988 – 2006 | 15 in. min. and 1 > 24 in. | 4 |
| | | 1987 | 12 in. min | 8 |
| | Panfish* | 2011 – present | | 15 |
| | | 1988 – 2010 | | 30 |
| | | 1987 | | No limit |
| | | | | |
| Watts | Muskellunge | 2007 – present | 40 in. min. | 1 |
| | | 1988 – 2006 | Catch and release | |
| | | 1987 | 36 in. min. | 3 |
| | Largemouth bass | 2007 – present | 15 in. min. and 1 > 21 in. | 4 |

| | | | | |
|---|---|---|---|---|
| | | 1988 – 2006 | Catch and release | |
| | | 1987 | 12 in. min. | 8 |
| | Panfish* | 2011 – present | | 15 |
| | | 1988 – 2010 | | 30 |
| | | 1987 | | No limit |
| | Saugeye | 2007 – present | 15 in. min. and 1 > 22 in. | 4 |
| | | | | |
| All refuge lakes not previously identified | Northern pike | 1993 – present | 28 in. max. | 3 |
| | | 1990 – 1992 | 24 in. min. | 3 |
| | | 1987 – 1989 | 24 in. min. | 6 |
| | Largemouth bass | 2007 – present | 15 in. min. and 1 > 21 in. | 4 |
| | | 1988 – 2006 | 15 in. min. and 1 > 24 in. | 4 |
| | | 1987 | 12 in. min | 8 |
| | Panfish* | 2011 – present | | 15 |
| | | 1988 – 2010 | | 30 |
| | | 1987 | | No limit |

**Appendix C. Glossary of fishery terms.**

**Alkalinity:** Alkalinity is a measure of a waters ability to resist a change in pH expressed in mg/l or ppm. Because alkalinity is dependent on minerals such as calcium (Ca), and this relates to aquatic vegetation production, alkalinity is a good indicator of a water bodies potential to produce fish. Less than 40 mg/l is considered soft water; greater than 40 mg/l is hard water.

**Catch per Unit Effort (CPUE):** CPUE is the catch per unit of sampling effort that is used as an index of abundance or to document population changes over time. This is also known as relative abundance. The formula is:

$$\text{CPUE} = \frac{\text{number of fish in a length class, length category, or sample}}{\text{Hour for electrofishing or net night}}$$

**Conductivity:** Conductivity is a measure of a water body's ability to conduct electricity, which is dependent on the amount of ions in the water. Total dissolved solids (TDS) is equal to 0.5 X conductivity. Conductivity is a good measure of a water body's productivity because of the relationship between minerals and productivity.

**Effort:** The effort is the total amount of time expended in collecting a sample. The time may be in hours, minutes, or net days. The effort is used to calculate CPUE.

**Memorable length:** The memorable length is a standard category unique for each species. The memorable length is the length that most anglers remember catching and is 59 to 64% of the world record length.

**Net-nights:** A unit of time used to describe the effort required to collect a sample using gill nets or trap nets. For example, if five gill nets were left for a 24 hour period, then five gill net-nights worth of effort were expended.

**pH:** a measure of how basic or acidic a body of water is. Pure water is considered neutral with a ph = 7. pH is on a Log10 scale, therefore a change of 1 pH unit equates to a 10 fold increase in $H^+$ (hydrogen ions). This information is important as many species of game fish have narrow pH tolerances.

**Preferred length:** The preferred length is a standard category unique for each species. The preferred length is the length that most anglers prefer to catch and is usually within a range of 45 to 55% of the world record length.

**Proportional Size Distribution (PSD):** PSD is the number of fish greater than or equal to a minimum quality length in a sample divided by the number of fish greater than or equal to a minimum stock length. The formula is:

$$PSD = \frac{\text{number of fish} \geq \text{"quality" length}}{\text{number of fish} \geq \text{"stock" length}}$$

**Quality length:** The quality length is a standard length category unique for each species of fish. The Quality length is usually within a range of 36 to 41% of the world record length and generally the minimum size that most anglers will keep.

**Relative Size Distribution (RSD – P):** The RSD – P is the number of fish greater than or equal to a minimum preferred length in a stock divided by the number of fish greater than or equal to a minimum stock size. The formula is:

$$RSD - P = \frac{\text{number of fish} \geq \text{"preferred" length}}{\text{number of fish} \geq \text{"stock" length}}$$

**Relative weight (*$W_r$*):** The relative weight of a fish or group of fish is referred to as a " $W_r$ " value. The relative weight is a comparison of the condition of the fish in a sample and the condition of a theoretical optimum sample. The formula is:

$W_r$ = (W/Ws) X 100

where "W" is the weight of an individual and "Ws" is a length specific standard weight.

**Standard error (SE):** Standard error indicates variability in a data set and is calculated as the square root of the variance ($s^2$) around the average divided by the number of samples (n): $\sqrt{s^2}/n$
The standard error is used to calculate confidence intervals.

**Stock length:** The stock length is the smallest of the standard length categories and is unique for each species of fish. The stock length is usually within a range of 20 to 26% of the world record length and at or near which a species reaches sexual maturity.

**Trophy length:** Trophy length is a standard length category unique for each species of fish. The Trophy length is size worthy of acknowledgment and is greater than 74% of the world record length.

**Variance:** Indicates how much sample observation are scattered around the average or mean of the sample. The variance is calculated as the sum for all observations as (sample mean – observed values)$^2$.

**Appendix D.  Data collection and analysis protocol.**

For each species, five fish per 10 mm (0.4 inch) for fish > 80 mm (3.2 inches) total length (TL) were weighed to the nearest gram (g) and measured to the nearest millimeter (mm). Fish smaller than 80 mm were tallied for length frequency analysis only. Once five fish were recorded for a 10 mm group, additional fish in that group were tallied for length frequency analysis only. Panfish, largemouth bass, and saugeye should use the 10-mm data sheet. Northern pike and common carp should use the 20-mm data sheet (Figures in this Appendix).

Catch per unit effort (CPUE) was recorded separately for each net and each electrofishing transect to enable calculating CPUE confidence intervals (CI) at the 80% CI level. CPUE and confidence intervals were analyzed using the one or two gears that are appropriate for each species of fish.

**Analysis of Data Collected**

1) Trends in relative abundance were assessed using catch-per-unit-effort (CPUE) as fish/trap net night, fish/gill net night, and for electrofishing fish/hr.

2) Size structure will be assessed with PSD and RSD. Length categories have been proposed for various fish species (Table I-1).

3) Calculating relative weight ($W_r$) assessed condition of fish by size groups (Table I-2).

Table I-1. Length categories that have been proposed for various fish species

| Species | Stock E | Stock M | Quality E | Quality M | Preferred E | Preferred M | Memorable E | Memorable M | Trophy E | Trophy M | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Saugeye | 9 | 23 | 14 | 35 | 18 | 46 | 22 | 56 | 56 | 69 | Flammang et al. 1993 |
| Yellow perch | 5 | 13 | 8 | 20 | 10 | 25 | 12 | 30 | 15 | 38 | Gabelhouse 1984 |
| Largemouth bass | 8 | 20 | 12 | 30 | 15 | 38 | 20 | 51 | 25 | 63 | Gabelhouse 1984 |
| White and black crappie | 5 | 13 | 8 | 20 | 10 | 25 | 12 | 30 | 15 | 38 | Gabelhouse 1984 |
| Bluegill, green sunfish, and pumpkinseed | 3 | 8 | 6 | 15 | 8 | 20 | 10 | 25 | 12 | 30 | Gabelhouse 1984 |
| Black bullhead | 6 | 15 | 9 | 23 | 12 | 30 | 15 | 38 | 18 | 46 | Gabelhouse 1984 |
| Common carp | 11 | 28 | 16 | 41 | 21 | 53 | 26 | 66 | 33 | 84 | Gabelhouse 1984 |
| Northern pike | 14 | 35 | 21 | 53 | 28 | 71 | 34 | 86 | 44 | 112 | Gabelhouse 1984 |

*Note: All measurements are total length. E = English units (inches). M = Metric units (cm).*

Table I-2. Intercept (a) and slope (b) parameters for standard weight (Ws) equations that have been proposed and the minimum total lengths (mm) recommended for application.

| Species | Intercept (a) M | Intercept (a) E | Slope (b) | Minimum total length | Reference |
|---|---|---|---|---|---|
| Black bullhead | -4.974 | -3.297 | 3.085 | 130 | Bister et al. 2000 |
| Black crappie | -5.618 | -3.576 | 3.345 | 100 | Neumann and Murphy 1991 |
| Bluegill | -5.374 | -3.371 | 3.316 | 80 | Hillman 1982 |
| Common carp | -4.639 | -3.194 | 2.920 | 200 | Bister et al. 2000 |
| Green sunfish | -4.915 | -3.216 | 3.101 | 100 | Bister et al. 2000 |
| Largemouth bass | -5.528 | -3.587 | 3.273 | 150 | Henson 1991 |
| Northern pike | -5.437 | -3.745 | 3.096 | 100 | Willis 1989 |
| Yellow perch | -5.386 | -3.506 | 3.230 | 100 | Willis et al. 1991 |

*Note: The standard equation format is Log10(Ws) = a + b(Log10 total length). Metric (M) equations are in millimeters and grams; English (E) equations are in inches and pounds.*

**Appendix E.** Mean lake levels (feet above mean sea level) for Clear, Dewey, Hackberry. Pelican, and Watts lakes from 1992 to 2011 (Figures I-1 to I-5). Mean lake levels were calculated twice each year as spring (March - June) and summer (July - October) levels. Stars indicate the highest and lowest recorded lake levels since 1992.

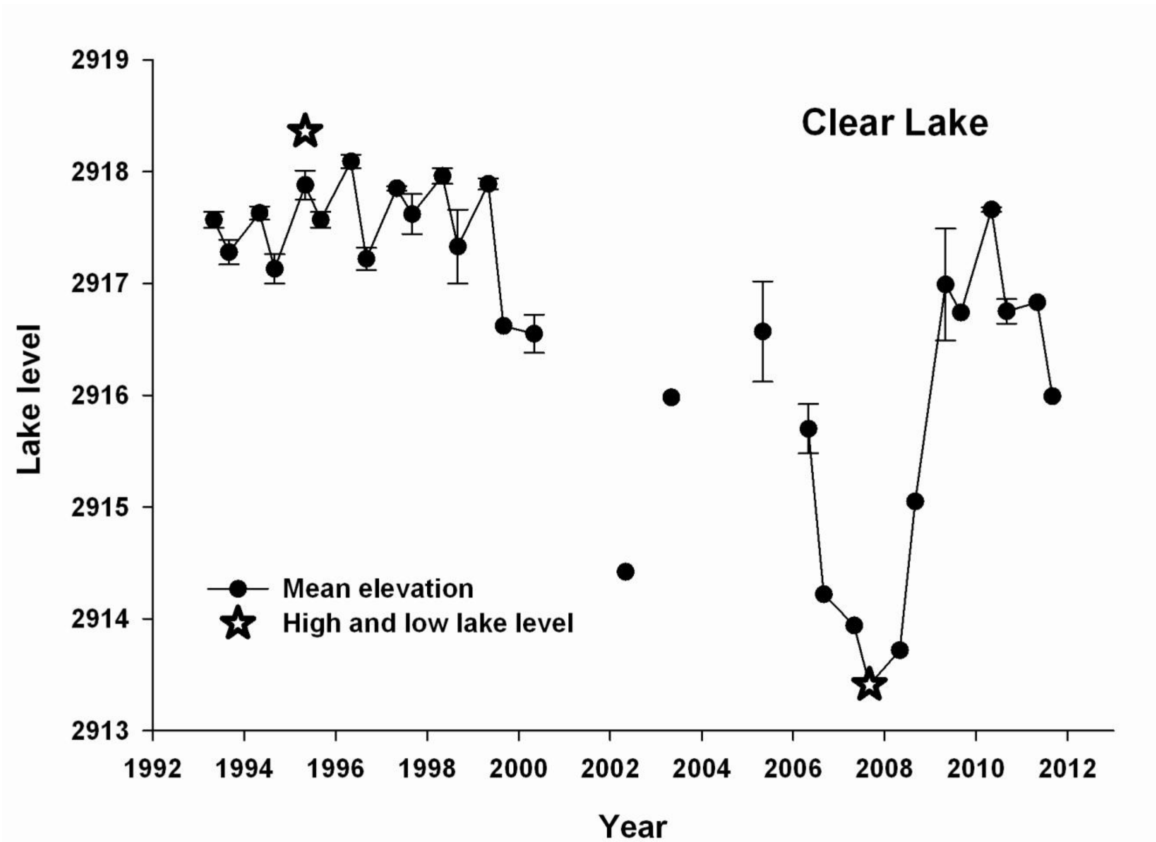


Figure I-1. Clear Lake mean lake levels during the spring and fall (± 1 standard error) from 1992 to 2011.

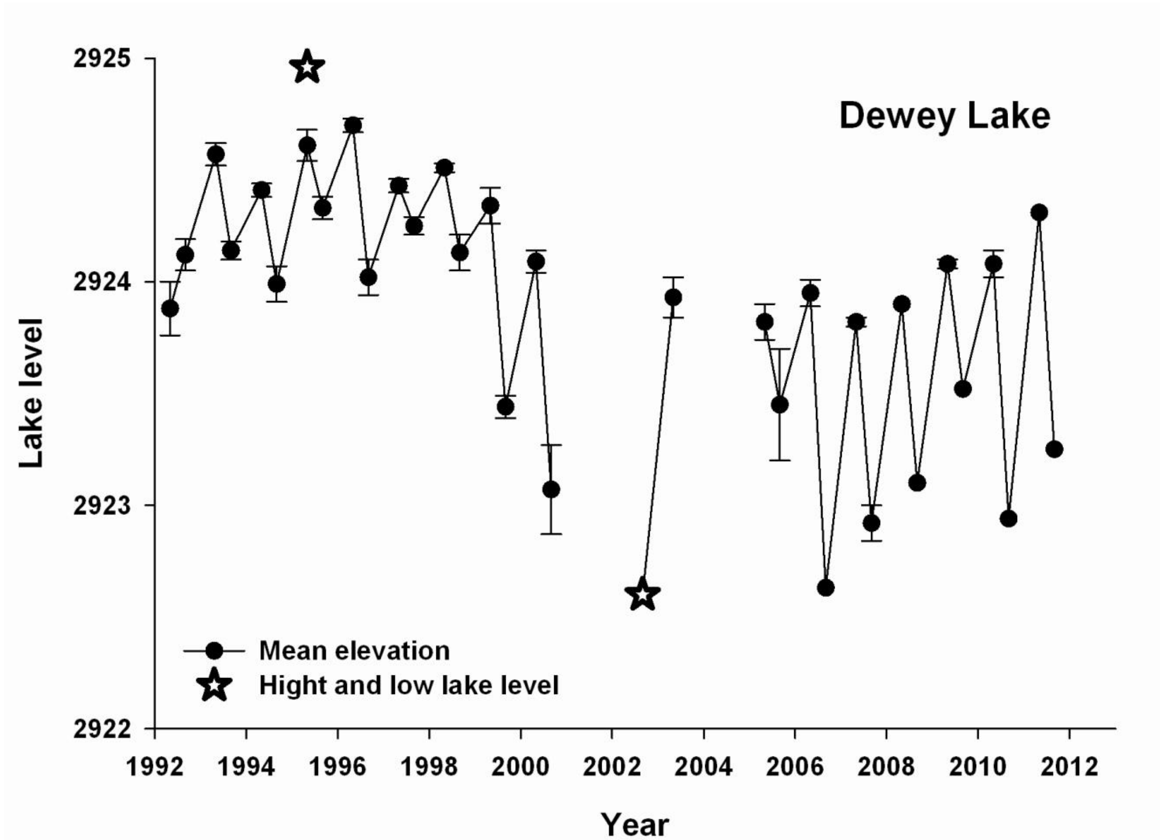

Figure I-2. Dewey Lake mean lake levels during the spring and fall (± 1 standard error) from 1992 to 2011.

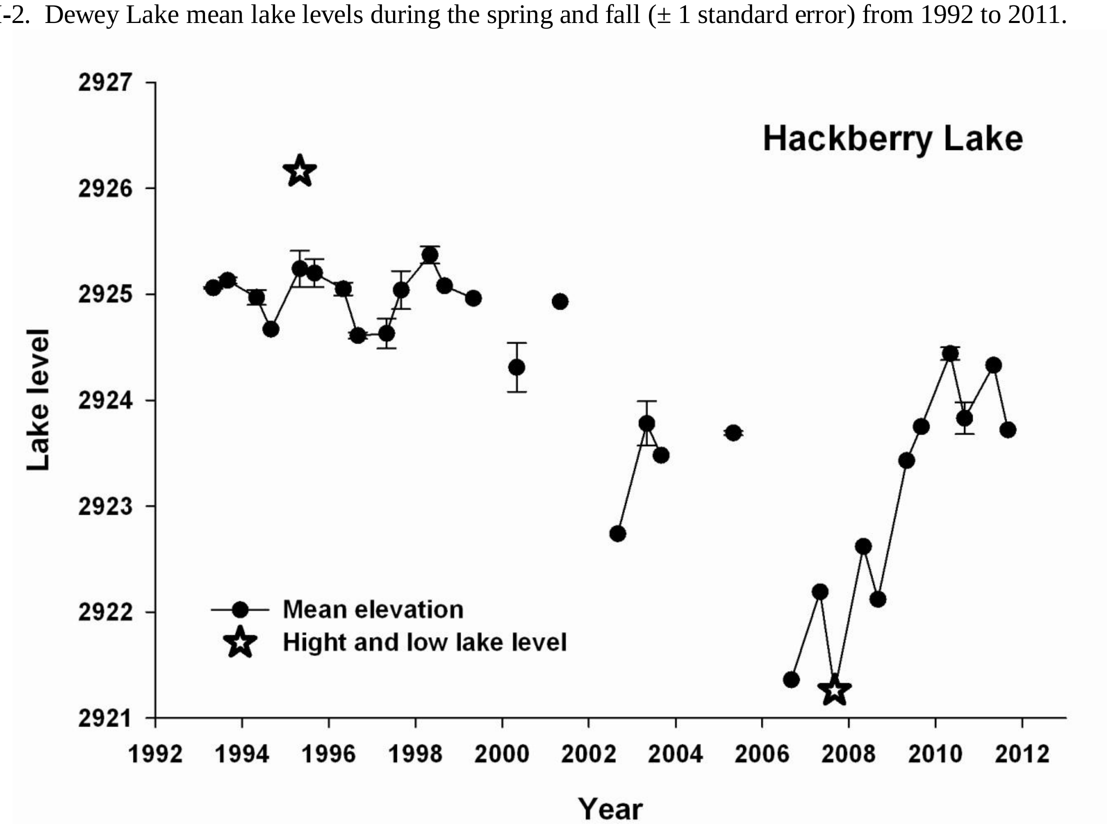

Figure I-3. Hackberry Lake mean lake levels during the spring and fall (± 1 standard error) from 1992 to 2011.

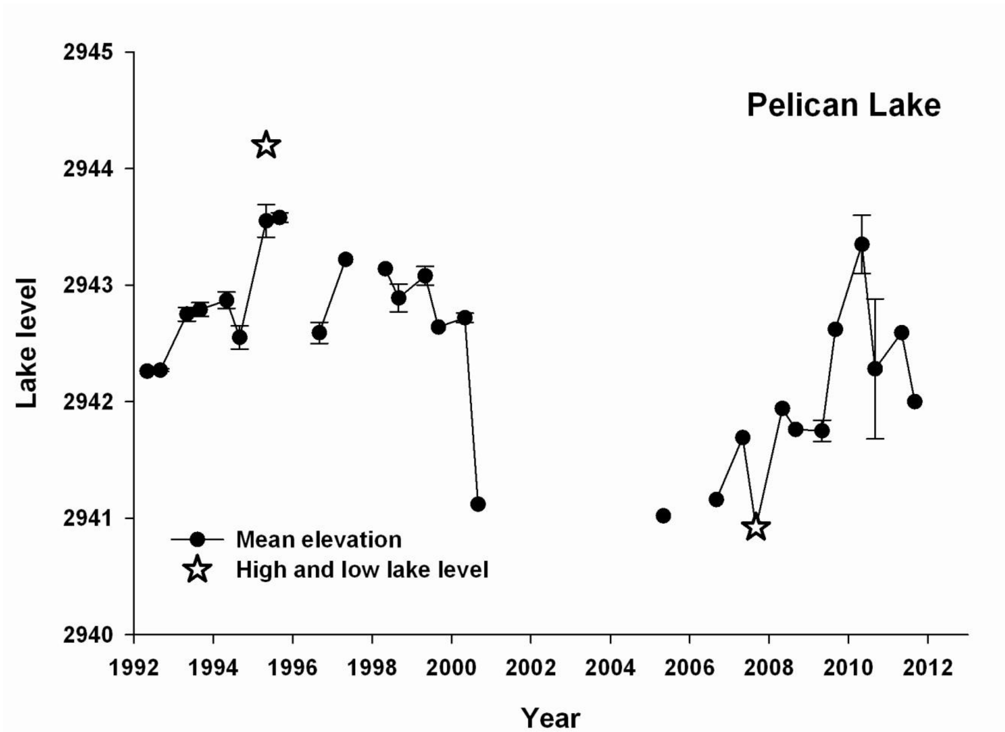


Figure I-4. Pelican Lake mean lake levels during the spring and fall with (± 1 standard error) from 1992 to 2011.

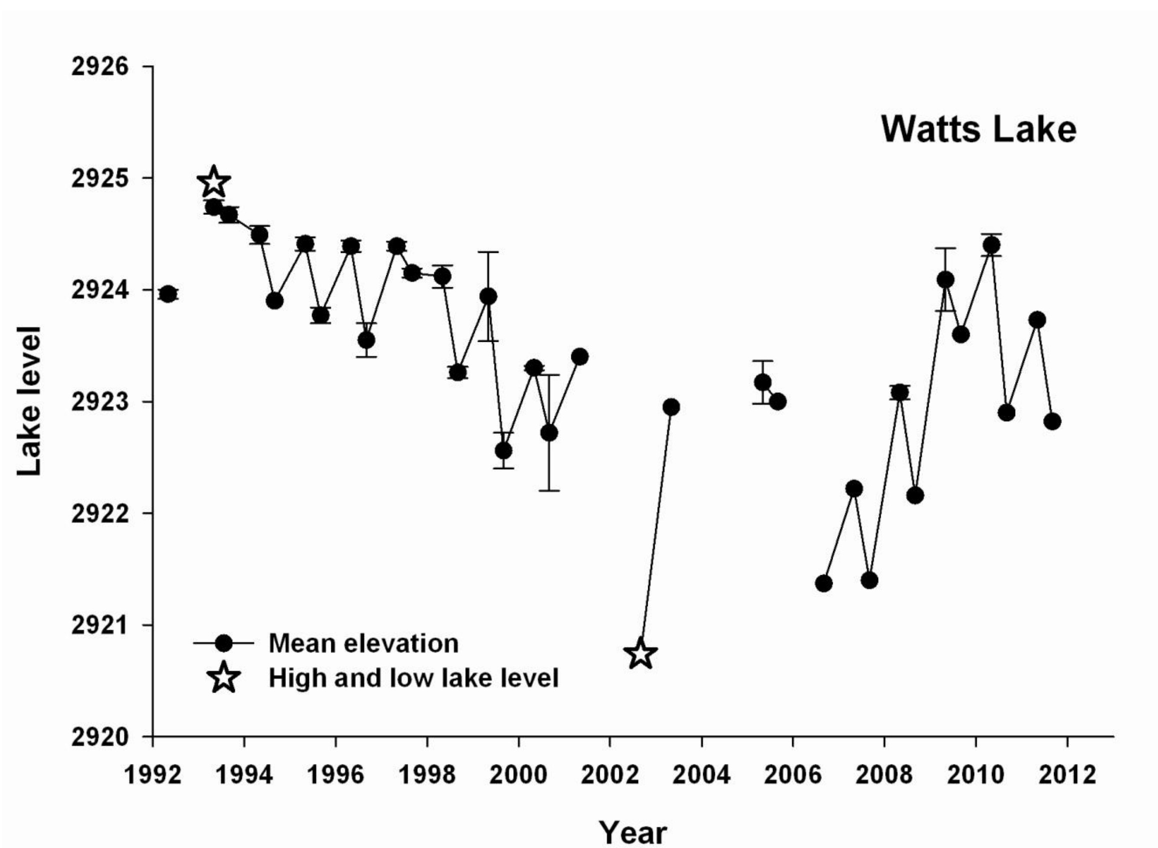


Figure I-5. Watts Lake mean lake levels during the spring and fall (± 1 standard error) from 1992 to 2011.

## Appendix F.  Turtle catches on Valentine NWR.

To reduce turtle mortality, all efforts are made to set trap nets so that the top of the cab remains just out of the water. Trap nets consisted of a lead set at the shoreline that is 15.2 m (50 ft) in length by 1 m (3 ft) in height, two 1.2 m (4 ft) wide and 1 m (3 ft) high rectangular steel frames, and two 1 m (3 ft) diameter circular hoops with 13 mm (0.5 in) nylon mesh. A green protective coat was applied to the nylon mesh. Trap nets were set overnight for a maximum of 24 h with leads set perpendicular to the shore. Mean CPUE was calculated as turtles/trap net-night (Table I-4).

Table I-4. Number (N) and mean catch per unit effort (CPUE; turtles/net-night) with ± 1 standard error in parenthesis for painted *Chrysemys picta*, snapping *Chelydra serpentina*, and Blanding's *Emydoidea blandingii* turtles captured in trap nets during the spring (S) and fall (F).

| | Painted | | Snapping | | Blanding's | |
|---|---|---|---|---|---|---|
| Sample period | N | Mean CPUE | N | Mean CPUE | N | Mean CPUE |
| | | | **Clear Lake** | | | |
| 2011 (S) | 3 | 0.3 (0.2) | 0 | | 0 | |
| 2010 (S) | 1 | 0.1 (0.1) | 0 | | 0 | |
| 2009 (S) | 17 | 1.7 (0.4) | 0 | | 0 | |
| | | | **Dewey Lake** | | | |
| 2011 (S) | 33 | 3.3 (1.3) | 2 | 0.2 (0.1) | 1 | 0.1 (0.1) |
| 2010 (S) | 22 | 2.2 (1.0) | 0 | | 0 | |
| 2009 (S) | 52 | 5.2 (3.0) | 0 | | 0 | |
| 2008 (S) | 11 | 1.1 (0.6) | 0 | | 0 | |
| 2008 (F) | 38 | 3.8 (1.4) | 0 | | 0 | |
| | | | **Hackberry Lake** | | | |
| 2011 (S) | 10 | 0.9 (0.4) | 1 | 0.9 (0.9) | 0 | |
| 2010 (S) | 11 | 1.1 (0.5) | 0 | | 0 | |
| 2009 (S) | 13 | 1.3 (0.8) | 1 | 0.1 (0.1) | 0 | |
| | | | **Pelican Lake** | | | |
| 2011 (S) | 22 | 1.8 (1.2) | 6 | 0.5 (0.2) | 0 | |
| 2010 (S) | 41 | 3.4 (1.6) | 0 | | 0 | |
| 2009 (S) | 64 | 5.3 (1.4) | 3 | 0.3 (0.3) | 0 | |
| 2008 (S) | 6 | 0.5 (0.3) | 0 | | 0 | |
| | | | **Duck Lake** | | | |
| 2010 (S) | 11 | 2.2 (0.7) | 0 | | 0 | |
| 2009 (S) | 59 | 11.8 (3.9) | 2 | 0.4 (0.2) | 0 | |
| | | | **Watts Lake** | | | |
| 2011 (S) | 81 | 11.6 (4.2) | 12 | 1.7 (0.8) | 0 | |
| 2009 (S) | 20 | 2.9 (1.3) | 0 | | 0 | |
| | | | **West Long Lake** | | | |
| 2010 (S) | 4 | 1.0 (0.4) | 0 | | 0 | |
| 2008 (F) | 1 | 0.3 (0.3) | 0 | | 2 | 0.5 (0.3) |

## Appendix G. Water Chemistry for Valentine NWR during 2011.

**Table I-5.** Results from water chemistry analysis for nitrate, nitrite, total nitrogen, ortho-phosphorous, total phosphorous, and ammonia from Clear, Dewey, Hackberry, Pelican, and Watts lakes sampled during the fall of 2011. Analysis was performed using a Hach DR – 2800 spectrophotometer.

| Date | Subsample | Date | Nitrate (mg/l) | Nitrite (mg/l) | Total Nitrogen (mg/l) | Othro-Phosphorous (mg/l) | Total Phosphorous (mg/l) | Ammonia (mg/l) |
|---|---|---|---|---|---|---|---|---|
| Clear | 1 | 8/30/2011 | 0.316 | 0.017 | | 10.3 | 8.32 | 0.005 |
| Clear | 2 | 8/30/2011 | 0.247 | 0.012 | | 56.8 | 30.6 | 0.064 |
| Dewey | 1 | 8/30/2011 | 0.312 | 0.024 | 3.26 | 17.6 | 12.3 | 0.064 |
| Dewey | 2 | 8/30/2011 | 0.314 | 0.018 | | 4.87 | 2.48 | 0.095 |
| Hackberry | 1 | 8/29/2011 | 0.298 | 0.02 | 3.55 | 2.63 | 15.6 | 0.096 |
| Hackberry | 2 | 8/29/2011 | 0.305 | 0.025 | | 3.61 | 3.99 | 0.106 |
| Pelican | 1 | 8/29/2011 | 0.306 | 0.015 | 2.71 | 2.92 | 4.77 | 0.184 |
| Pelican | 2 | 8/29/2011 | 0.297 | 0.021 | | 2.27 | 12 | 0.107 |
| Watts | 1 | 8/30/2011 | 0.322 | 0.024 | 3.65 | 3.99 | 1.31 | 0.088 |